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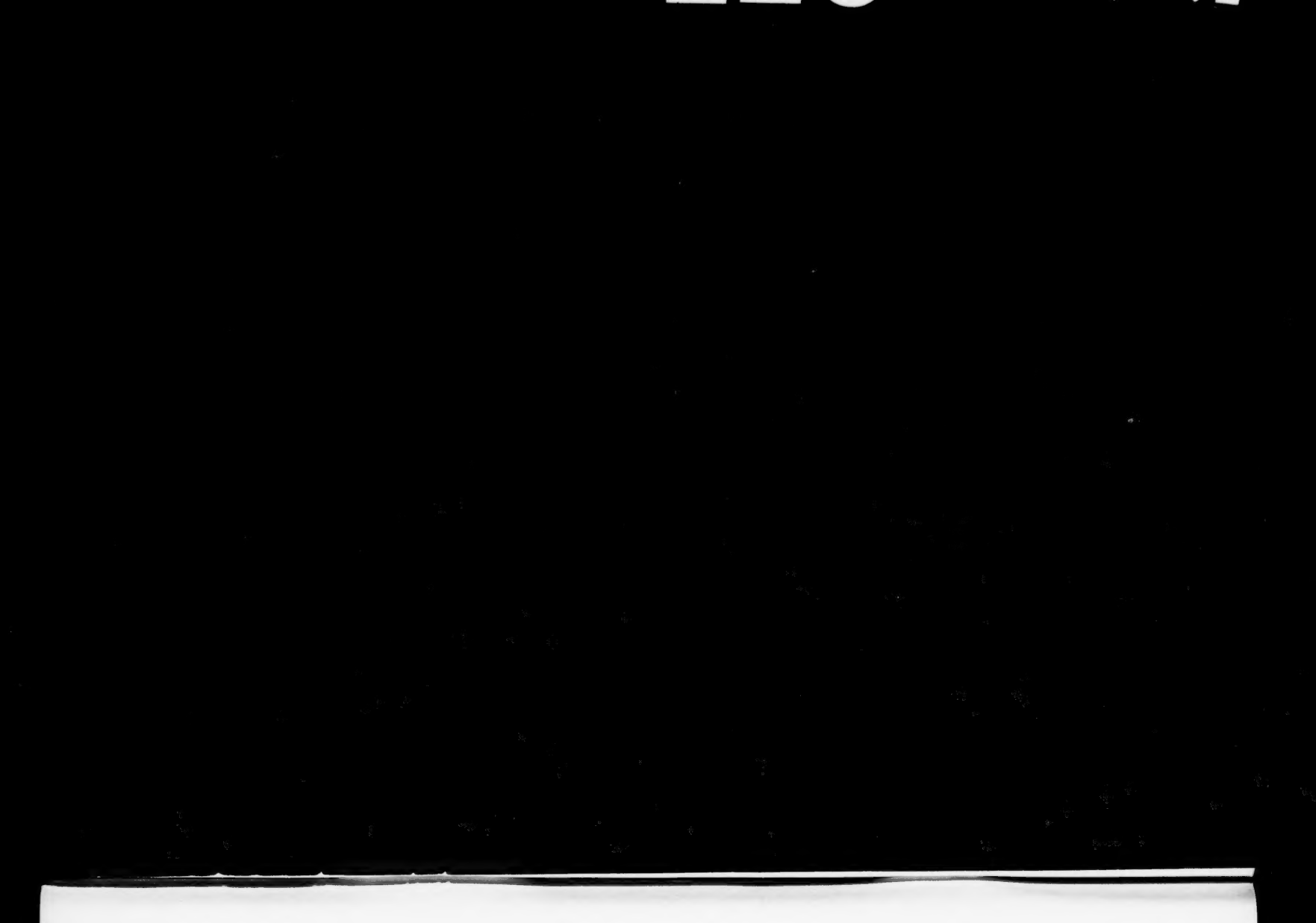

OBSERVATIONS ON THE MICHIGAN FLORA, V: PLANTS OF THE ST. IGNACE CAUSEWAY (MACKINAC COUNTY)—THE SECOND FOUR YEARS[1]

EDWARD G. VOSS[2]

INTRODUCTION

During the summer of 1948 I prepared for this *Journal* an annotated list[3] of the 75 species of vascular plants which had become established on the causeway constructed in the Straits of Mackinac southwest of St. Ignace (Mackinac County) by the Michigan State Highway Department. Completed and abandoned in the spring of 1944, this pile of limestone blocks extends southerly into the Straits for almost a mile, with a roadway on top the width of a four-lane highway.

Another four years having elapsed, on July 12 and September 2, 1952, I again studied the causeway flora. Brief visits were also made on July 27 and August 6, 1953. Since the proposed bridge across the Straits is again under consideration, it is uncertain how much longer there will be opportunity to study the establishment of vegetation on the deserted causeway before it is finally put to use as the north approach of a bridge. Although cars may drive to the end of the structure, there is hardly any reason, except satisfaction of curiosity, to do so. The average tourist, however, is curious; and certainly the source of a portion of the flora of this bleak habitat must be attributed to the vehicles and people which briefly come out to the end. In 1953, a small shelter was built at the outer end of the causeway for radio equipment used in connection with the laying of the Canadian oil pipeline across the Straits somewhat over one and half miles west.

The frequent visits of fishermen (sometimes as many as 12 or 15 at a time) to the concrete highway bridge near the north [shore] end undoubtedly account for the greater variety in the flora in the vicinity of the bridge. As in the original survey, the bridge was taken as a convenient line of demarcation north of which [shoreward] no observations were recorded.

The general aspect of the vegetation is more luxuriant than four years ago. Although very common before, *Melilotus alba* has spread even more widely, as have *Fragaria virginiana* and *Matricaria matricarioides*. *Medicago lupulina* is likewise abundant. Among the woody plants, *Populus balsamifera*, *Shepherdia canadensis*, and *Cornus stolonifera* are the most striking and are apparently thriving. On the other hand, some species, *e.g.*, *Cerastium vulgatum*, *Capsella*

[1] Contribution from the Biological Station of the University of Michigan.

[2] Class of 1950, Denison University.

[3] See "Literature Cited" for all references mentioned in this report.

bursa-pastoris, *Erucastrum gallicum*, and *Anaphalis margaritacea*, have become noticeably less common.

FACTORS AFFECTING THE FLORA

Various factors must receive attention in considering the changes in the flora which have taken place in four years, and one of the first to suggest itself is the character of the soil. As would be anticipated in disintegrating limestone, which forms the fill on the top of the causeway, the pH is high. Several readings were made with a pocket Hellige soil tester in 1952 and 1953, in a variety of sites at the edges of the marly or muddy puddles in the center of the roadway and in the soils of the higher and better drained spots. All reactions were around pH 8 or 9. Comparing the causeway flora as far as possible against a recent compilation of pH preferences (Spurway, 1941), we find that for only a few of the plants is the upper limit of the optimum range given as higher than pH 7.5. Even allowing a tolerance greater than this optimum, we would still seem to have a flora in large part at the edge of, or even beyond, its normal tolerance, assuming the tests to have been approximately reliable.

However, at least half the species found on the causeway in the 1948 and later surveys are weedy plants, often known as such because of their wide ecological amplitude or frequency in colonizing disturbed habitats. On the newly constructed causeway, in the absence of competition, they had opportunity to take advantage of the full range of tolerance of which they were genetically capable.

It might be, especially for some of the native species, that calcicolous ecotypes exist. This idea was put forth, at least for certain woody plants, by Potzger in his surveys of Mackinac and Round Islands in the Straits of Mackinac (1941, 1944). The occurrence of physiologically calcicolous or alkaline-tolerant races of native plants on the causeway, then, would be no more remarkable than their occurrence on the neutral to highly alkaline soils of the neighboring shores of the mainland and islands, where the underlying rock is often near or even at the surface. (Cf. Landes, Ehlers, & Stanley, 1945.)

A patch of *Arctostaphylos uva-ursi* was found in the 1948 survey (though it apparently did not survive). Evidence for a wide range of soil reaction for this member of a typically acid-loving family has been summarized by Wherry (1920, p. 104). The species occurs commonly on limestone gravels elsewhere in the Straits region. What other species, one wonders, illustrate a similar range when occasion permits, and would the soil immediately surrounding the roots of these plants, if critically analyzed, demonstrate the pH recorded for the soil in general?

The Leguminosae are well represented in the flora and are a flourishing part of the vegetation. Their frequency on calcareous soils in relation to the favorable environment there provided for the appropriate symbiotic bacteria has been mentioned by Salisbury (1920, p. 205). (Cf. also Small, 1946, p. 126.)

Although it may have been a selective factor in the failure of certain plants to survive, the strong alkalinity of the habitat or its calcareous nature (no direct

test of calcium was made) cannot be considered the important over-all influence on the vegetation which a first impression might lead us to suspect. Too many plants have survived or even thrived on it. We can only observe that really characteristic plants of acid habitats are lacking (*e.g.*, *Rumex acetosella* or *Linnaea borealis*), whereas those common on calcareous shores are represented (*e.g.*, *Carex garberi*, *Gentiana procera*, *Lobelia kalmii*).

Another factor which may have influenced the character of the flora is the scarcity of pollinating insects, even on relatively calm days. This fact, which was called to my attention by Howell V. Daly, Jr., is easily understood in view of the very exposed situation of the causeway, its narrow surface always swept by the full force of whatever winds may blow through the Straits. Of the 10 species which were originally reported in 1948 and not found in 1952 or 1953, five are annual or biennial weeds (none wind-pollinated), the continued existence of which would depend on the appropriate insects at the proper time, on vegetative propagation, or on continual re-establishment from the mainland (or, of course, on self-pollination or on apomixis, which may permit the perpetuation of *Polygonum aviculare*, an annual found in 1952).

A human factor which could account for the absence of a few of the plants in 1952–53 is simply that they may all have been collected in the course of the 1948 survey, at which time no particular thought was given to the possibility of returning at a later date. The original report notes "one plant" of *Echium vulgare*, and although abundant on nearby roadsides, it had evidently not re-established itself by 1952, although two small plants were found near the bridge in 1953. Some of the other species not found again may have shared a similar fate. *Anthemis cotula*, on the other hand, a weedy annual, was abundant on the causeway in the early years but now seems to have completely disappeared, while *Matricaria matricarioides*, also common formerly, has become even more abundant now.

COMPOSITION OF THE FLORA

As expected in a flora at least half of which is composed of weeds, the proportion of annuals and biennials is relatively high. Of the total causeway flora of 103 species, about 28% are annuals or biennials, 55.5% herbaceous perennials, and 16.5% woody perennials. A more natural, less disturbed area, but one roughly similar in size and location, with which this spectrum may be compared is Green Island, a tiny island in the Straits of Mackinac about one and a half miles west of the causeway (Voss, 1950). The flora of Green Island, 137 species in all, is established on a sand and gravel ridge which rises gradually to scarcely two meters at its crest above the water level (less in high water years); this contrasts with the causeway, the surface of which is raised well above the highest waves which beat against the steeply pitched 15-ton limestone blocks below. Although people do visit Green Island occasionally, they must travel by boat, and the human influence is correspondingly less. Scarcely 4–5% of the species on Green Island are so aquatic that they could not be expected in at least the moister

regions on the causeway, other conditions being suitable (these are all herbaceous perennials). A comparison of the floras is given in the table below:

	GREEN ISLAND	CAUSEWAY
Total number of spp.	137	103
Weeds	26–27%	50%+
Annuals & biennials	16%	28%
Herbaceous perennials	61.5%	55.5%
Woody perennials	22.5%	16.5%

LOWER PLANTS

No lower vascular plants were noticed on the causeway in 1948. The gymnosperms are now represented by only two small plants of *Picea glauca*, and there are still no pteridophytes. The bryophytes and lichens were collected in July, 1953, by Raymond E. Hatcher, and I am indebted to him, to Dr. Margaret Fulford, and to Mrs. Joyce H. Jones for their determination. No fleshy fungi have been seen. Some of the plants show symptoms of disease; particularly noticeable in September, 1952, was the rust *Coleosporium solidaginis* (Schw.) Thüm., observed by Donald G. Palmer to be at least as common on the *Solidago* of the causeway as on the same plants elsewhere in the region. (Determination confirmed by Dr. E. B. Mains.) I collected a few algae on August 6, 1953, and these were kindly determined by Miss Shirley Sparling and confirmed by Dr. G. M. Smith.

LISTS

In the lists which follow, the nomenclature of the vascular plants follows the 8th edition of *Gray's Manual*. Specimens collected (not all species were taken) are for the most part in the Herbarium of the University of Michigan Biological Station, at Douglas Lake; a few are in the herbaria of the University of Michigan, of Southern Methodist University (Asters), and of the writer. I am indebted to Dr. L. H. Shinners for aid in determination of several Aster collections, most of which confirmed the presence of the species previously reported, and to Dr. F. J. Hermann for identifying the *Carex garberi*.

I. Corrections in identity

The "*Salix* sp." of the 1948 list has been examined by C. R. Ball, who writes that it is "S. Bebbiana Sarg., unfertilized and possibly hybrid. . . . The sterile twig is normal mature appearance."

"*Lepidium virginicum* L." was included in the 1948 list, but specimens examined in 1952 are *L. densiflorum* Schrad. These species have generally been confused in the region in the past, and it is probably *L. densiflorum* which was seen in 1948.

The plant originally reported as *Diplotaxis muralis* (L.) DC. is actually *Eru-*

castrum gallicum (Willd.) O. E. Schulz. (Cf. Voss, 1950, p. 187.) *Erucastrum* differs from *Diplotaxis* (at least so far as these species are concerned) in its four-angled siliques, bracted racemes, and retrorsely appressed stem pubescence.

"*Ribes cynosbati* L." was listed in 1948. The dwarfish specimens collected in 1952 appear to be *R. hirtellum* Michx. var. *calcicola* (Fern.) Fern., although the single fruit found (immature?) was red. Presumably the plants seen in the original survey were the same.

"*Aster junceus* Ait." The specimens are *A. pilosus* Willd. var. *pringlei* (Gray) Blake, a plant much misinterpreted in the local flora in the past. True *A. juncifformis* Rydb. (= *A. junceus* of authors) is a very slender plant with thread-like rhizomes of the same thickness as the stem.

II. Species found in 1948 but not in 1952 or 1953

Although diligent search was made, some, at least of the smaller of these, may conceivably have been overlooked. Others may have been unable to survive the soil conditions, the scarcity of pollinating insects, the depredations of the collector, or other factors. Our knowledge is too incomplete and the extent of the flora too small to draw any final conclusions in specific cases.

Rumex crispus L.
Erysimum cheiranthoides L.
Trifolium procumbens L. [It is possible that the original report was based on a collection of *Medicago lupulina*.]
Epilobium glandulosum Lehm. var. *adenocaulon* (Haussk.) Fern.
Daucus carota L.
Arctostaphylos uva-ursi (L.) Spreng.
Lycopus americanus Muhl.
Verbascum thapsus L.
Anthemis cotula L.
Senicio pauperculus Michx.

III. Additions to the list of the vascular flora

The following 28 bring to a total of 103 the species found at one time or another on the causeway. Some, of course, may have been present in 1948 but were overlooked then. Except as noted, all of these are 1952 collections. The four marked with an asterisk have apparently not been previously reported for Mackinac County; specimens of these have been placed in the Herbarium of the University of Michigan Biological Station.

Picea glauca (Moench) Voss
Two small plants near the bridge.
Agropyron repens (L.) Beauv. var. *repens*
Locally common at the end of the bridge.
* *Alopecurus aequalis* Sobol. var. *aequalis*
Locally common in moister places.
Carex aurea Nutt.
Scarce; a small patch found near the bridge in 1953. Reported for Mackinac

Island by Dodge (1913) but presumably for lack of a supporting specimen, not by Hermann (1941).

Carex garberi Fern.

One patch near the preceding, 1953.

**Juncus bufonius* L.

Locally forming dense mats in marly ground.

Polygonum aviculare L.

Common in moist marly ground.

Chenopodium album L.

Scarce; two plants near the bridge (one collected).

Cerastium arvense L.

One small matted patch at southern end of the causeway, 1953.

Sisymbrium altissimum L.

Scarce; two plants near the bridge (one collected).

Geum aleppicum Jacq. var. *strictum* (Ait.) Fern.

Scarce.

Medicago lupulina L.

Abundant throughout.

**Potentilla recta* L.

Prunus pumila L.

One shrub (not collected).

Rhus radicans L.

A very few small and unhealthy-looking patches on the north half of the causeway.

Impatiens sp.

Probably *I. capensis* Meerb. A few seedlings seen on the west side, in cracks in the large limestone blocks.

Hypericum kalmianum L.

One plant (collected) 2 dm. tall, at least 3 years old, heavily fruiting.

Gentiana procera Holm

Frequent.

Cynoglossum officinale L.

One plant (collected) near the bridge.

Prunella vulgaris L.

Occasional.

Satureja acinos (L.) Scheele

One plant (collected) near the bridge.

Linaria vulgaris Mill.

One patch along the eastern edge, and scattered individual plants.

Plantago major L.

Common. Bases of petioles red, but capsules as in this species.

Campanula rotundifolia L.

Two or three small clumps.

Antennaria neodioica Greene var. *chlorophylla* Fern.

Uncommon in dryish ground.

Erigeron philadelphicus L.

Infrequent.

Solidago hispida Muhl. var. *hispida*

One plant (collected).

**Tragopogon major* Jacq.

Not seen in 1952, but Frank C. Gates found "a single specimen" on the causeway June 18, 1951. (Biological Station Herbarium)

IV. Cryptograms (1953)

Algae.—In addition to numerous diatoms, several blue-green and green algae are established:

Haematococcus lacustris (Girod.) Rostaf.

Gives a prominent red color to the bottoms of small water-filled pits in the large stone blocks, where the spray from waves would keep the pits filled.

Ulothrix zonata (Weber & Mohr) Kütz.

Common just below the water level of the Straits of Mackinac, attached to the large blocks of limestone. Some groups of filaments are bright green, but others appear brownish because the filaments are covered to 10 or more times their diameter with diatoms.

Lyngbya sp.

Forming, with *Calothrix*, a dark coating on the stone blocks at and above the water level.

Microcoleus sp.

Inconspicuous as small blue-green spots on the exposed mud of receding puddles on the upper surface of the causeway.

Calothrix sp.

At or near the water level of the Straits, forming a dark scum on the stone blocks (with *Lyngbya* and diatoms).

Bryophytes.—Mosses are conspicuous in some places; six species were collected by Raymond Hatcher, as follows:

Ceratodon purpureus (Hedw.) Brid.

Grimmia apocarpa Hedw.

Bryum caespiticium Hedw.

Brachythecium sp.

Campylium hispidulum (Brid.) Mitt.

Drepanocladus sp.

The *Brachythecium* and *Drepanocladus* are very poorly developed and sterile, and evidently are having a difficult time.

Lichens.—Three crustose lichens occur on the rocks of the causeway:

Verrucaria rupestris Schrad.

Placynthium nigrum (Huds.) S. F. Gray

Bacidia inundata (E. Fries) Koerb.

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SONIC AND ULTRASONIC EFFECTS ON MAZE LEARNING AND RETENTION IN THE ALBINO RAT

PETER F. GILBERT[1] AND GARY C. V. GAWAIN[2]

INTRODUCTION

The experimenters became interested in this problem after learning about a siren developed at The Pennsylvania State College which was capable of producing sounds of extremely high intensities and frequencies (2). These sounds were powerful enough to kill mice, burn cotton in a matter of seconds, boil coffee, suspend marbles in mid-air, disperse fog and smoke, and wash clothing cleaner and faster than the best washing machines. What effects such sounds might have on humans was not known, yet there were some jet engine pilots and mechanics being exposed to some of these sounds every day. The United States Air Force was also interested in finding out more about these sounds. This research, then, is part of the work done cooperatively by the Departments of Bacteriology, Physics, Psychology and Zoology at the Pennsylvania State College, under contract No. AF 33(038)-786 administered by the Sound and Vibration Unit, Biophysics Branch, Aero Medical Laboratory, Engineering Division, Air Materiel Command, U. S. Air Force, Wright-Patterson Air Force Base, Dayton, Ohio.[3]

PILOT STUDIES AND PROBLEM

Many pilot studies were done to ascertain what animals, learning apparatus, sound intensities and frequencies, and techniques would be best to employ. Lethal exposures and secondary effects of exposure had to be considered. For instance, the experimenters found that a sound of about 6 kc and 154 db re. threshold would kill a rat in about two minutes. As a result of these studies and information gathered from numerous sources, the sound intensities, frequencies, and the experimental design discussed later were used. It was also decided to use albino rats and the Warner-Warden Standard Unit Maze (4, 5). Rockland complete rat diet was used throughout the experiment.

The problem of this research was to determine what effects there were, if any, of sonics and ultrasonics on maze learning and retention in albino rats.

ANIMALS

A total of 237 animals was used in this research. This number includes all animals used in the pilot studies as well as in the experiment proper. Pilot studies were done on albino rats, black rats, pied rats, white mice, and black

[1] Consulting Psychologist, Rohrer, Hibler and Replogle, New York City.
[2] Assistant Professor of Psychology, Denison University.
[3] The writers are indebted to this source for funds which made this research possible.

mice (C-57). One hundred eighty-five male albino rats (Wistar strain), 67 to 72 days of age, were used in the experiment proper. Of this number 106 completed all phases of training.

SOUND SOURCE

The sound source for this experiment was a siren developed by Rudnick and Allen (2). The siren was maintained and operated by the Physics Department at The Pennsylvania State College.

The intensity levels that will be reported in this study were obtained by calculation based on measurements of the sound pressure. These measurements were made with several completely different microphones. Rochelle Salts microphones, and barium titanate microphones (1) were used. Measurements made by physicists over a period of three months, using the three kinds of independently calibrated microphones, agreed with each other to within 1.0 db maximum spread.

Frequency measurements were made by oscilloscope comparisons with a Hewlett-Packard Model 200-D Oscillator. The manufacturer specifies the calibration to be accurate to 3% of the frequency measured.

All sound levels in this study are given in decibels referred to threshold values for a plane wave. Threshold pressure is 2×10^{-4} dynes/cm^2; the corresponding threshold intensity is 10^{-16} watts/cm^2. The values given are for the fundamental frequency only.

It should be emphasized that the sound levels quoted are those which existed in the free field; i.e., in the sound field before any experimental animal was placed there. Under all conditions the free field sound level (for the fundamental) was found to be uniform to within 1.0 db over the region to be occupied by the subject. However, the presence of any body such as that of an animal has a disturbing effect on the sound field. Thus, the sound pressure near the surface of a typical rat was found to vary from about 6 db above to 6 db below the sound pressure level existing in the free field; i.e., in the same locality with the animal removed. In this report the free field sound levels are stated rather than those actually existing near the animal bodies under exposure conditions because the former are much more reproducible.

SOUND LEVELS

With regard to the sound levels to be studied, the experiment was divided into two phases. In the first phase the frequency was held constant at 6 kc, and the intensity was varied at 5 sound levels: 110, 120, 130, 137, and 147 db. In the second phase of the study the intensity was held constant at 120 db, and the frequency was varied in five steps: 8.5, 15, 21.5, 28, and 33 kc. In both phases each experimental animal was exposed at one of the sound levels for 1.5 minutes. In addition to the experimental groups of animals, a group of control animals was employed in each phase of the study. The control animals were treated exactly the same as the experimental animals, except that when they were placed in the siren cabinet, the siren was not turned on.

PROCEDURE

1. The animals were starved for 44 hours immediately prior to the beginning of training.

2. A group of six animals was randomly placed, one at control and one at each of the five experimental sound levels.

3. Errors, time, and trials on the mazes were recorded.

4. On the first day the animals were trained to run the Warner-Warden maze (4), linear pattern (5) with six culs-de-sac (RLRLRL), to meet a criterion of three out of four errorless trials.

5. On the second day the animals were exposed to the experimental sound variables, and three minutes after exposure they were rerun on the same maze that they learned the first day to meet the same criterion. This was designed to determine any effects on retention.

6. On the third day, approximately 24 hours after exposure, the animals were trained on the Warner-Warden maze, with six culs-de-sac, but on this day the pattern was changed (LLRRLR). The animals were trained to meet a criterion of three out of four errorless trials. This was designed to determine any effects on new learning.

Steps 1 through 6 were repeated every three days until an N of 106 was obtained. In order to stabilize the means at the control levels, two extra control groups were run on the intensity phase and one extra control group was run on the frequency phase.

RESULTS

Errors, time and trial scores were recorded for all animals, and the data were tested for significance by analysis of variance. F-tests were separately made on the error, time, and trial data for effects of exposure on retention and new learning on both phases of the experiment. Furthermore, F-tests were applied in a variety of ways. First of all, they were made comparing the six means, one control and five experimental, to see if any of the means were significantly different from the others. Then F-tests were made using only the experimental means to see if any of the exposures had significantly different effects from the others. Finally, F-tests were made taking the control mean score versus the combined mean score of all experimental groups to see whether or not the accumulation effect of exposure was significant. It was felt that this last application was justified since both groups were treated qualitatively differently, i.e., all experimental animals were exposed, and all controls were not exposed to sonic or ultrasonic stimulation.

On the intensity phase of the experiment significant differences at the .05 level of confidence or below were found in only one instance. This occurred when the mean error scores of the control animals were compared with the combined mean error scores of all experimental animals on new learning. This might seem to indicate that exposures to high intensity sounds have a detrimental effect

on new learning in terms of error scores. However, in view of the fact that so many other F-tests failed to show significance, it might be that this one instance of significance could still have occurred simply by chance. At any rate, the authors are reluctant to say that positive results have been conclusively demonstrated.

On the entire frequency phase of the experiments no significant differences at the .05 level of confidence were found.

Split-half reliability coefficients (scores on odd versus even trials for each animal) were determined for the two mazes used in this study. The reliability coefficients for the initial learning maze (RLRLRL) for errors and time were .67 ± .04 and .82 ± .03, respectively. The reliability coefficients for the new learning maze (LLRRLR) for errors and time were .87 ± .02 and .94 ± .01, respectively.

Pearson product-moment coefficients of correlation between the measures of learning were found to be as follows (N = 62): errors and time = .73 ± .04; errors and trials = .67 ± .05; time and trials = .57 ± .06.

Pearson product-moment and rank difference coefficients of correlation between the mazes for each of the measures of learning were determined as follows: (N = 20 intensity controls) r(errors) = −.25 ± .14; r(time); = −.07 ± .15; r(trials) = −.07 ± .15; ρ(errors) = −.44 ± .08; ρ(time) = .04 ± .15; ρ(trials) = −.19. ± .15.

Coefficients of variation for each of the measures of learning were computed on initial learning (before exposure) to determine their relative consistency or reliability from level to level. The results on the intensity phase for errors, time, and trials were 43.78, 57.81 and 33.36, respectively. The results on the frequency phase for errors, time, and trials were 25.88, 61.61, and 27.78, respectively. Time was the most unreliable or inconsistent in both phases. Trials were the best measure on the intensity phase, and errors were the best measure on the frequency phase.

CONCLUSIONS

Although there was some indication that exposures of 1.5 minutes to sounds of approximately 6 kc and 110, 120, 131, 137, and 147 db may have had a detrimental effect on maze learning ability of the male albino rat (Wistar) when these animals were trained on the Warner-Warden Standard Unit Maze approximately 24 hours after exposure, conclusive evidence of this has not been demonstrated.

These same exposures seem to have no significant effect on the retention ability of these rats, when they were run 3 minutes after exposure on the same maze that they learned approximately 24 hours earlier.

Exposures for 1.5 minutes to sounds of approximately 120 db and 8, 15, and 21.5, 28, and 33 kc fundamental frequency seemed to have no significant effects on maze learning or retention of the male albino rat under the same conditions as described above.

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WINTER DISTRIBUTION OF THE EASTERN CARDINAL IN THE VICINITY OF MORGANTOWN, WEST VIRGINIA[1]

MARION L. HUNDLEY[2]

I. INTRODUCTION

The Eastern Cardinal *Richmondena cardinalis cardinalis* (Linnaeus) has been recognized as a species since the publication of the 10th edition of Linnaeus' "Systemma Naturae" in 1758. Since that time knowledge of the life history of the species has grown and scientific methods have advanced. Some life history phases have, however, been incompletely treated.

The authors of standard ornithological texts have either adhered to old data and theories concerning the winter distribution of the Cardinal, or have made statements of an ambiguous nature resulting from unreliable and unorganized observations. "Winter wandering" and "extension of range" are two phrases which have been substituted for exact data and only occasionally are the words "transient" or "migrant" used.

Scattered local winter records of Cardinals from widespread bird banders have been reported to the United States Fish and Wildlife Service but these have not been assembled and are not available to the writer. Similarly, A. C. Bent's life history study of the *Fringillidae* is not yet in print.

The Cardinal occurs in North America as far west as 100 degrees longitude, north to 48 degrees latitude, and south to Mexico, a wide range. Over much of this area the Cardinal is a common permanent resident, so common in fact, that his winter distribution has been almost ignored. At the time the Cardinal reaches the northern or western periphery of his range he is such a rarity that he is not described as a normal representative of his species as he is known in West Virginia. Several states have named the Cardinal as their State Bird.

Data pertaining to the Cardinal in its winter period are almost entirely lacking in published form. Since survival of the species is largely dependent upon its survival during the winter season, definite ecological data are very important in explaining the birds' winter distribution in local areas. The occurrence of the Cardinal in all of West Virginia, except the higher mountain ridges, as a very common permanent resident warrants some modern research on the bird's present status in winter.

The Cardinal has been called "non-cyclic," perhaps referring to the idea that it is not migrant, that it is little affected by overall climatic severities, or that it

[1] Parts of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, West Virginia University, 1952.

The cardinal is the *Richmondina cardinalis cardinalis* (Linnaeus), A. O. U., Number 593.

[2] Class of 1935, Denison University.

is able to remain in a static condition of population once it has adapted itself to the environmental changes caused by man. However, it may be established that the species is, although highly adaptive locally, subject to cyclic effects of abundance of water, cover and natural food in winter.

This research concerns known distances and directions travelled by Cardinals during the winter months of September through April in the vicinity of Morgantown, West Virginia.

A Cardinal *aggregation* is the coming together of all ages and sexes of the species to roost and feed during the winter. The aggregations range in number from a few to as many as 100, depending upon the density of population and the available food and cover.

The following are definitions of banding terms: *Repeat*—the recapture of a banded bird at its original banding station within a period of six months. *Significant Repeat*—the recapture of a banded bird within six months time but at a different station situated less than one mile from the original point of capture. *Return*—the recapture of a banded bird that occurs at its original banding station after six months have elapsed since its last occurrence at the station. *Recovery*—(As applied to Cardinals in winter)—the recapture of a banded bird at a distance of error of over one mile from where it last occurred as a record.

II. REVIEW OF LITERATURE

Literature relating to the actual distances Cardinals wander in the winter is scarce. There are probably unpublished records of winter recoveries in the files of the United States Fish and Wildlife Service. Since these records are unavailable to the writer, a thorough search of literature reveals few data. So little attention has been given to Cardinal banding that the correct band size for the species was not established until October, 1950.

Groskin (1950) reported 28 returns from a total of 361 Cardinals banded from May, 1937 to October, 1950 at a permanent banding station of unknown capacity in Ardmore, Pennsylvania. These returns are based on birds retrapped from six months to four years after original banding. No intermediate calendar data were given. Eleven recoveries, birds reported by the United States Fish and Wildlife Service as having been found dead, were found at a distance of no more than two miles from the point of original banding and eight of these were reported from Ardmore. No directions were included, but ten of the bird records occurred during winter months. Seven of the recoveries were of immature Cardinals. The three recoveries of greatest distance were banded as two immature females and one adult male, but all were classed as adults at the time of recovery. The statement is made that "the evidence that the Eastern Cardinal is actually a permanent resident is found in the banding records of recoveries reported to the United States Fish and Wildlife Service."

The 13 years of banding by Groskin were decidedly discontinuous during the winter months. Twenty-five of the non-banding months were critical mid-winter months.

Further data are contained in a letter from Groskin in October, 1951. He

states, "An immature female banded on October 6, 1939 was retrapped on October 25, 1939 at Overbrook, Pennsylvania, two miles distant." He also states that nine of 36 Cardinals returned during winter months but in different winter seasons. Eight of 13 recoveries were found dead in winter from one to *three* miles from Ardmore, Pennsylvania.

Unpublished data contained in a letter from Paul E. Downing, who operates a permanent banding station in Highland Park, Illinois, provide records of six Cardinals from 156 originally banded. An adult female banded on April 20, 1938 was recovered *five* miles south at Glencoe, Illinois on February 3, 1940. Another adult female banded on December 6, 1937 was a recovery at another bander's station *eight* miles south at Hubbard Woods, Illinois on April 1, 1938. An immature male banded on July 25, 1940 was recovered *twelve* miles north at Waukegan, Illinois on October 21, 1940. These remarkable records suggest that the Cardinal is not restricted in its wanderings where the population of the species is not as heavily concentrated as it is in this particular problem area.

Three local recoveries were reported to Mr. Downing and contained dates applicable to winter distribution.

Of 78 adult Cardinals banded in winter months, October through March, 12 individuals repeated at Mr. Downing's station within a period of 60 days. Of 17 immature birds banded, only three repeated. The data indicate that a fair percentage of birds of all ages were wandering, or were at least very apprehensive of recapture.

Of 14 station returns seven were females and seven were males, indicating, by the sporadic appearance at a definite location over a period of five years, that there is some static tendency.

Forbush and May (1939) state that the Eastern Cardinal "winters throughout its range." They also state, "Where the birds are numerous they can be found in gardens about houses, in bushy thickets everywhere, in heavy growth along swampy streams and in mixed woodlands." In other words the Cardinal is very adaptive in its habitat requirements.

Studer (1895) writes, "The Cardinal is common in southern states and is found in great numbers in middle and western states. When the winters are mild he remains in middle and western states but in severe winters he wanders toward the south." This information is not based on any known accurate data but would imply a forced migration.

Todd, in Christy's publication (1942), commented on the extension of the species' northern range. "Being a seed eater and ground feeder the Cardinal cannot maintain itself in force within the area of snow cap that in winter for weeks on end rests upon the northern states." No comment was made regarding what happens to the northerly nesting birds when this snow cap arrives in winter. If they are forced to seek warmer snow-free areas the move south must be considerable in extent, forcing a transient, if not migrant, classification upon those birds affected.

Pough (1946) says, "The Cardinal is non-migratory but wanders extensively. A gradual northern spread is evident."

Chapman (1929) limits the range of the Cardinal to the Carolinian and Austro-riparian Faunas.

Peterson (1947) limits the northern range of the Eastern Cardinal to Southern New York, Lake Erie (southern Ontario), southern Minnesota and southeast South Dakota. He calls the species "non-migratory".

Todd (1940) observes that "the first recorded appearances of Cardinals (in a northward extension of their range) are nearly always in winter. . . . Its ultimate range is conditioned by winter rather than summer; thus temperature is therefore responsible. . . . Like other birds the Cardinal wanders during winter in search of new feeding grounds but it is not migratory in the usual sense of the word."

Roberts (1936) states, "The Cardinal occurs as a resident breeding bird in southeastern Minnesota . . . and is extending its range north and west. A fairly common permanent resident, the first birds seen were single males in *fall, winter* and *spring* as visitants appearing at widely scattered localities."

Lewis (1937) writes that "a female Cardinal was observed feeding at Milton, Massachusetts on December 8 and 16, 1935."

Christy (1931) declares that three Cardinals were observed at Winous Point in Sandusky Bay, Ohio in 1880, but that by 1930 the birds were considered fairly common and well distributed.

Taverner (1927) notes that "a male Cardinal was collected at Goulais Bay, Saulte Ste. Marie, Ontario, on November 7, 1923. Other Cardinals were observed at Ottawa, Canada, on November 28 and 29, 1924."

Baldwin (1922) reports records of bird banding returns of four Cardinals and includes stations marked as "A", "B", "C" and "D." These records involve winter distribution but no distances between stations are available. He states that "of 28 birds taken from previous years 14 were resident."

Baldwin (1921) states that during his banding operations in Cleveland, Ohio "an unusual number of Cardinals, both males and females appeared all through March and I banded 29 new ones, though I had banded only 36 all told in the three previous seasons of 1915, 1916 and 1917. Could they be migrants?"

Cooke (1914) observes, "The Cardinal is an abundant resident at Caddo, Oklahoma. During the fall many were found among weed patches around cotton fields but were silent and shy. Late in November when most leaves had fallen they retreated to stream thickets. When real winter began they flocked into town for as long as snow lasted."

Trautman (1941), in his observations at Buckeye Lake, Ohio, made several pertinent statements. "Cardinals were found occupying territories throughout the entire winter season (P. 121)." A chart (P. 141) shows a decided increase in Cardinal abundance from late February until early April and another increase from early October until mid-November. The median dates of spring arrival (P. 395) were February 27 and departure April 8. The fall arrival median date was October 2 and departure November 14 (P. 396). "There is a slight indication of semi-annual migrations in the seasonal and annual fluctuation in numbers. . . . Throughout the winter the conspicuous Cardinal gathered in flocks of from four

to 60 individuals. . . . In a few instances a decrease in wintering numbers was noted immediately following a severe sleet or snow storm of exceptionally long duration. . . . In March the species appeared to be more numerous than in winter indicating the possible presence of transients. . . . On a few occasions small groups of apparent transients were seen dropping to earth from *high in the air*. . . . By early April the winter groups and transients had disappeared. . . . (P. 397) From early October to early November an increase in daily members (of Cardinals) was noted. . . . Small groups, possibly transients, could occasionally be seen dropping out of the sky. . . . Upon the coming of the first snows or cold weather in late November, many (Cardinals) again began to congregate in dense thickets and woodlands."

Borror (1950) simply calls the Cardinal a "very common permanent resident" of Ohio.

Bartel (1951) reports 22 returns and six recoveries of Cardinals in 13 years of banding at Blue Island, Illinois. By 1952 he had banded 202 Cardinals since 1933 and, in a personal unpublished letter, made additions to the few distance recovery records. Three Cardinals, of six recorded recoveries, were found at distances of two, six and 10 miles from his station. These all involved winter dates and all had travelled in a northeasterly direction. The 10 miles were travelled in one year but the age and sex of this individual were not recorded. The two miles were covered by a female in eight months, and the six miles were covered by a female in six and a half years. Of 21 birds classed as returns, 12 were females.

E. A. Brooks (1915) says "the Cardinal (in West Virginia) is only locally migratory, gathering in the colder days of winter in the more sheltered places, but remaining throughout the winter near the same section of country in which it spends the summer."

Howard Young (1946) located the center of Cardinal population in Kentucky with a figure of 5.95 Cardinals per man hour based on the average of 10 years' Christmas bird counts. West Virginia ranks fifth in comparison with 3.22 birds per man hour. He also gives a map charting the range spread in Wisconsin from 1900 until 1946. He also concludes that the Cardinal is non-cyclic and that the bird is slowly spreading from the Austral Region into the Canadian Zone.

Young, in an unpublished letter (1952), reports an adult female Cardinal banded on April 5, 1950 recaptured at a distance of one mile on January 5, 1952 in the vicinity of Fayetteville, Arkansas. He also includes winter dates involved in three returns of birds banded in 1950–51 in Fayetteville, and one return in 1948–49 season from Madison, Wisconsin.

Cooke (1946) cites six Cardinal winter banding recoveries in which Cardinals of unknown age and sex originating in six widespread locations travelled in winter from 35 to 145 miles. One travelled north, one travelled west and the rest travelled southeasterly. The article included several other long distance recovery records for Cardinals but these did not occur in winter.

Reuss (1952), in an unpublished letter, reports that an adult female banded September 28, 1950 at his banding station in Blue Island, Illinois was found

dead 12 miles southeast on May 9, 1951. He also reports 20 returns, 15 of which were females involving dates from January 1, 1937 to the present.

M. G. Brooks, in Christy's article (1942), points out that "Cardinals are decidedly social (among themselves) particularly in winter." They show varying degrees of tolerance between the sexes during different winter months. He also notes that Cardinals react differently when observed within the central portion of their range as contrasted to reactions of the same species at their northern range periphery.

Many other observations dating back into the mid-Nineteenth Century, but none of them with corroborative data concerning actual distances travelled in the winter season, are to be found in ornithological literature.

III. THE PROBLEM OF WINTER DISTRIBUTION

Winter distribution of the Eastern Cardinal has been under the observation of, and has been commented on by, many ornithologists, including field observers and bird banders, for over half a century.

The main deficiencies of published records arise from the inability of the observers to distinguish between individual birds in a free and natural condition. This results in the absence of proven distances travelled in the winter phases of the life history of the species.

Individual recognizable field marks are too rare among Cardinals to indicate the true status of the species in even a limited area. It is true that an occasional bird will lose its retrices or produce some strictly temporary field mark. Rarely a melanistic male may have distinguishable brown spots on its body, or an individual with a leukistic spot may display a sure identifying mark to the observer.

Bird banding records divulge a few short distance recovery records of dead or retrapped Cardinals. However, these records, although giving definite distances and dates, include little data relevant to directions travelled or to the events of a single winter season. Most of the records of individual birds indicate nothing of where the birds have been from one season to another because the means of establishing these data were by erratic, very localized retrapping during as many as 13 years.

The long distance records do not originate from areas comparable to the present study area. However, these banding records establish the fact that the Cardinal can and does travel distances of as much as 145 miles during the winter season. They also indicate that the percentage of birds involved is greater than formerly suspected and that even greater distances may be travelled.

The United States Fish and Wildlife Service "Manual for Bird Banders" requires a move of five miles before a bird can be classed as a foreign "recovery" in distinguishing between a recovery and a station "return." However, in the case of a permanent resident species, five miles may be over the limit of a bird's wanderings during its entire life span. It is thus apparent that there are some individuals which will wander several miles and never even be seen, let alone recaptured. In a recent bulletin the United States Fish and Wildlife Service states that in the case of permanent or winter residents, distances of over one

mile are to be considered recovery records for local information purposes. This applies to the Cardinal.

Basic to scientific study are means of capturing and marking a fair representation of Cardinals for future observation. This involves much preparation in locating high population concentrations. It necessitates some prior indication of how the species travels in the chosen research area. Study must be made of the topographic conditions and possible avenues of travel regarding presence or absence of continuous cover, coupled with knowledge of the flight traits of the species in order to establish potential distribution.

In choosing the research area, abundance of available wild food, proximity of permanent water, potential disturbances by predators and human meddlers, and availability of good roosting and feeding cover are prime considerations. The student must consider his own financial and time limitations.

Population concentration is important because it may greatly influence the distances Cardinals can travel in competition with its own and other species. Casual observation must suffice at first but definite estimates of population must be made as the problem progresses. Bi-monthly population counts are made in which the same trail is consistently covered. These counts should include areas adjacent to the banding stations within radii of one half mile only. The number of Cardinals seen and heard, one way only, composes the total. The averages of these counts may indicate a figure that is near the total Cardinals in the area, but discrepancies will exist. Deletion of food supply and critical weather conditions are to be considered. The counts may indicate directions marked or unmarked birds are wandering. The presence of boundary lines between definite aggregations may be indicated.

The effort must be made to distinguish between static permanent resident birds and unsettled transient individuals, with an effort to distinguish between ages involved. Limits of daily feeding range may be established. Parallelism between age or sex groups may be observed, particularly when increases or decreases in population are noted.

Observations at ever-widening radii from the banding stations must be made in order to obtain definite distances involved in the "wanderings." The final range should be computed as twice the greatest distance a marked bird has been observed from its point of original marking. The assumption involved is that one bird may wander in any direction and may reverse directions if the first trial proved unsuitable to the bird's needs. Or two birds, originally marked at the same station, may wander in opposite directions. Individuality is an accepted character of the species, thus the individual bird reaction can only be a measure of the group reaction. Family or group reactions are to be expected and would be dependent upon the motivating force.

A single observer cannot obtain many long distance records in a single season because he will seldom be at the proper locations at the proper times. A single observer cannot band and observe during the same period of time. However, indications of direction and distance movements may be observed in and about the station areas. The absence of appropriately placed cooperative banders is a

great hindrance, as are the lack of time and absence of more widely scattered stations. It may be possible that volunteer spot observers will add some data from outer peripheries.

Inquiries are to be made concerning such phases of winter distribution as the time of parental release of late broods, molting and post-molting wanderings of both immature and adult birds, formation of aggregations, roosting after the fall of deciduous leaves, feeding competition, pre-mating reactions to warm weather during winter, and the increase in population and shifts occurring in March.

Other inquiries into wanderings caused by predation, clearing, and other human interferences are necessary. Occurrence of aggregations due to a lack of competition and/or because of a necessity of coming together in a common roost may be indicated. The spring shift and break-up of aggregations is gradual and could be due to greater nesting territory requirements. Sexual behavior may be dormant in winter months with short daylight hours, but indications of awakening may occur.

Recent standard texts continue to repeat ancient data for facts not particularly applicable to present environmental factors. Indeed, to survive the Cardinals have had to make progress and many adaptations. A modern approach to the ecological situations of the present is necessary.

The problem, although limited in both time and areas, is the basis for a future cooperative long time study. A plea is offered to interested parties to induce landowners to leave the wild tangles, fence rows and other cover for birds whenever humanly practical.

IV. DESCRIPTION OF THE STUDY AREA

An area, bounded on the west by 79°58′ longitude, on the east by 79°54′ longitude, a distance of approximately 3.80 miles, and bounded on the north by 39°40.4′ latitude, on the south by 39°36.6′, a distance of approximately 4.75 miles, was chosen as the critical study region. The area of the region is 18.05 square miles but due to physical and time limitations of the observer only the good cover portions of the area were properly investigated.

The area concerned was once a plateau which was deeply eroded after land emergence to give rise to a mature topography of rolling hills. Outcropping rocks of the area are of the Paleozoic era and the greatest abundance of strata are from the Carboniferous age in the Pennsylvanian subdivision which again subdivides into Monongahela, Conemaugh, Allegheny and Pottsville Series. A small corner in the southeast contains Mauch Chunk and Greenbrier Limestone series. At present the area varies in elevation from 793′ at the level of the Monongahela River to the highest point at 1240′, but the greater portion falls in an average elevation between 1100′ and 1200′. The higher level ground, starting at the airport in the east, continues in a general northwesterly direction through Star City.

The region is entered from the south by Cobun and Aaron Creeks, from the southeast by Decker's Creek and Knocking Run, all of which flow in a general

northwest direction into the Monongahela River which enters the region from the southwest and continues in a northerly course. West Run enters the area at an eastnortheastern point and pursues a northwesterly course to enter the Monongahela River. Several small streams, flowing westerly, drain the higher elevation into the Monongahela River and several more flowing generally northeast drain the northeastern side of the high ground into West Run. All of these spring-fed streams cut deeply into the higher plateau and form many steep wooded ravines. They also cause much variation in the facing of the many slopes.

The area is laced with many secondary dirt roads, some of them inaccessible in winter but is also crossed by several black-top primary roads, namely State Route 7 which parallels Decker's Creek on the east and the Monongahela River on the west, State Route 73 which enters from the northeast and Cheat Lake and continues south along the Monongahela River to Fairmont, West Virginia, and U. S. Route 119 which enters the area in the north from Pt. Marion, Pennsylvania, and continues south along a ridge toward Grafton, West Virginia.

The region presents a patchwork of urban and interurban areas with the latter varying between wild and domestic conditions, with valleys and level areas farmed and natural hills and ridges wooded or punctured and scraped by coal mining operations.

The plant formation of the region is deciduous forest with Mixed Oak Associations dominating the higher portions of south and west facing slopes, while Beech-Maple Associations are found on lower portions. Variations of Mixed Mesophytic Associations are found on north and east facing slopes. A predominance of yellow poplar, *Liriodendron tulipifera*, and woody or herbaceous lianas, particularly wild grapes, *Vitis spp.*, are noted along with several Beech, *Fagus grandifolia*-Maple, *Acer spp.*, Associations which are located on south and west facing slopes. Due to cutting there is much secondary growth. In many locations old field successions are found in the black locust, *Robinia pseudo-acacia*, stage. Mining, strip mining, and lumber operations have anteceded many shrub and vine tangles, and many open areas in the woods and in fields at wood's edges have been invaded by hawthorn, *Crataegus spp.*, patches. Herbaceous plants and weeds of food value to wild creatures are in great abundance. The West Virginia University Horticultural Experiment Farm, West Virginia University Dairy and Stock Farms, and the West Virginia University Poultry Farm occupy a large portion of the study area and present optimum food, nesting, and roosting conditions for Cardinals. See Figure 1, which is a section of a Morgantown, West Virginia, quadrangle map; United States Department of the Interior, Geological Survey.

V. THE BANDING STATIONS

After preliminary information was gathered and investigation concerning possible sites for Cardinal banding stations was made, four locations were chosen. Property owner permission was granted for use of each site.

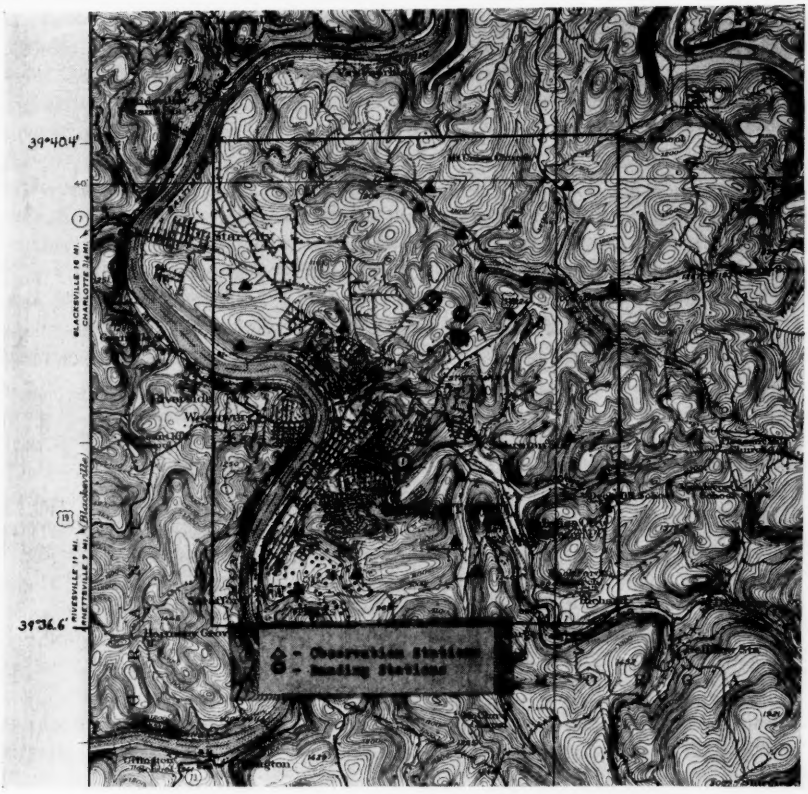

FIG. 1.

Station 1 was installed on October 2, 1950 on the property of Mrs. Robert Guy on Preston Avenue adjacent to the J. R. Moreland property to the south. The situation was on a "hog-back" ridge top, elevation 1100′, which had a gentle south slope. The station was placed away from public view behind a growth of weeds and wild black cherry, *Prunus serotina*, seedlings. At one side good cover was provided by domestic plantings of heavy shrubs and evergreens and on the south was a high shrub hedge.

The plant species in the immediate vicinity were of both natural and domestic origin. Mr. Moreland had planted over 90 species of plants native to West Virginia on his property. The main station area plants were composed of wild black cherry, black locust, hawthorn, and sugar maple, *Acer saccharum*; hemlock, *Tsuga canadensis*, red spruce, *Picea rubens*, white birch, *Betula papyrifera*, *Rhododendron sp.* and many domestic shrubs composed the introduced species while beech, black oak, *Quercus rubra*, yellow poplar, American elm, *Ulnus*

americana, and flowering dogwood, *Cornus florida*, composed the dominants of the natural plants. Wild grape, honeysuckle, *Lonicera japonica*, Virginia creeper, *Parthenocissus quinquefolia*, and greenbrier, *Smilax sp.* composed the vine tangles in the vicinity. Seed-bearing herbs and composites of domestic origin were abundant. Wild onion, *Allium cernuum*, was the abundant ground cover with but few grasses interspersed. Running water was available.

Station 2 was installed on October 2, 1950 on the West Virginia University Horticultural Experiment Farm at a point about .2 miles from the main entrance gate on West Virginia State Routes 73 and 119. It is 125 paces to the station area along the first road to the right after passing the gasoline pump.

The area is on a gentle southeast-facing slope at an elevation of 1200 feet. To the north and west of the area paralleling the main road is a 500 feet long and 100 feet wide crescent of red pine, *Pinus resinosa*, the average height of which is 30 feet. Smilax and wild grape are invading the growth. A planting of American flowering crab, *Malus coronaria*, was nearby, covered with wild grape vines. Other canopy trees in the area were slippery elm, *Ulnus fulva*, yellow poplar, wild black cherry, red maple, *Acer rubrum*, sugar maple, black walnut, *Juglans nigra*, tree of heaven, *Ailanthus altissima*, herculesclub, *Aralia spinosa*, shagbark hickory, *Carya ovata*, black gum, *Nyssa sylvatica* and butternut, *Juglans cinerea*.

Staghorn sumac, *Rhus typhina*, ironwood, *Ostrya virginiana*, redbud, *Cercis canadensis*, sassafras, *Sassafras albidum*, and spice-bush, *Lindera benzoin*, composed the main occupants of the secondary layer. Scattered patches of elderberry, *Sambucus canadensis*, hydrangea, *Hydrangea arborescens*, and blackberry, *Rubus sp.*, composed the high shrub layer and all were abundant.

Pokeweed, *Phytolacca americana*, poison ivy, *Rhus radicans*, greenbrier, honeysuckle vines, virginia creeper, spiraea, *Spiraea virginiana*, and blueberry, *Vaccinium* (cultivated sp.), composed the lower shrub stratum.

Small patches of black locust, 10 to 20 feet high, abounded in cleared edges. A large hillside domestic grape arbor was near as were many neglected domestic apple trees and an experimental currant and gooseberry plot.

Seed bearing herbs and grasses were abundant as the ground layer, with many weeds in neglected areas and many wild onions and dewberries, *Rubus flagellaris*.

Running fresh spring water was available nearby.

Station 3 was installed at an elevation of 1200 feet on October 2, 1950 in the area adjacent to the experimental blueberry plot .3 miles to the north of Station 2. The area is on a southeast-facing slope and is an old-field, good-soil succession surrounded by a cultivated apple orchard, a truck garden, a grape arbor and blueberries.

The dominant trees are black locust accompanied by black walnut, sumac, sassafras, wild black cherry and sugar maple. Shrubs are the cultivated blueberries, poison ivy, virginia creeper and elderberry. Herbaceous plants and grasses compose the ground cover along with wild onion and dewberries.

Station 3A was later installed on December 31, 1950 at a point .75 miles west-northwest of Station 2 at the extreme northwest line of the Horticultural Ex-

periment Farm on a flat ridge top at an elevation of 1240 feet. The area cover is a mixture of cultivated plants and natural secondary growth. The natural growth consists of black locust, wild black cherry, hawthorn and sassafras. The shrubs appearing in the area are blackberry, raspberry, *Rubus occidentalis*, smilax and poison ivy. Much of the ground cover is of wild onion, grasses and dewberries.

Natural running water is not located near the station.

Station 4 was installed in the northeastern edge of the city of Morgantown on Falling Run Road at a point 100 yards northeast of the intersection of Falling Run Road and Protzman Avenue at an elevation of 1000 feet. The station area was originally at a point 30 feet northeast of the Falling Run water pumping station underneath a box elder, *Acer negundo*, on the north facing slope adjacent to Falling Run Road in an area shaded most of the day. Later the spot was proven unsuitable so the station was relocated nearby on the Waters' property behind the unusually constructed house.

The station was placed on a southeast facing, steep slope terrace adjacent to a growth of black locust which was in an early growth stage of succession. In the immediate vicinity are sycamore, *Platanus occidentalis*, wild black cherry, apple, *Malus pumila*, and basswood, *Tilia americana*. The shrubs present are raspberry, blackberry and domestic plantings, while pokeweed, wild onion, grasses, and herbs compose the ground layer.

Plenty of fresh water is near the station.

The Morgantown Quadrangle Topographical Map of the United States Department of the Interior, Geological Survey, which has the station marked with appropriate colors and numbers is included as Figure 1.

The distances and directions between stations, as the Cardinals fly in this vicinity, or a series of short flights in any direction during their daily activities involving cover and feeding areas, are as follows:

TABLE 1

Sta. 1	to Sta. 2	N.N.E.	1.75 miles
Sta. 1	to Sta. 4	N.N.W.	1.2 miles
Sta. 2	to Sta. 3A	N.W.	0.75 miles
Sta. 2	to Sta. 3	N.	0.3 miles
Sta. 2	to Sta. 4	S.W.	1.2 miles
Sta. 3A	to Sta. 4	S.S.W.	1.3 miles
Sta. 3A	to Sta. 1	S.	2.0 miles

VI. PROBLEMS OF ESTABLISHMENT

Capturing Cardinals for study necessitated the use of suitable traps and bait. Operation began in late September, 1950 with Federal Bird Banding Permit #6204 and the West Virginia State permit in possession. The construction of traps was begun with enough one-fourth inch mesh hardware cloth at hand to make seven traps and a carrying cage.

The first seven traps were designed on the wrap-around principle. The largest two were 18 inches high and had a diameter of 16 inches. Three were intermediate

in size with 12 inch heights and 12 inch diameters and two were small, being nine inches high and nine inches in diameter.

It was later found necessary to install drop doors on all of these traps since the birds seemed able to learn the means of exit. The drop door rested on a peg until the bird's body contact tripped the door. The high traps were eventually cut down, as bird removal proved difficult because of too much evasive space within the trap.

Seven traps were installed among the stations on October 2, 1950 on the ground in anticipation of the Cardinal habit of ground feeding.

Ordinarily tags are placed on each trap for owner identification but these appeared to be distracting to the birds so they were removed in lieu of single larger station signs.

As the research continued the need for more and different type traps became apparent. A Gill one-cell trip-step trap was purchased and its immediate success on November 10, 1950 prompted the construction of similar traps as often as practical. See Figure 2. These were installed on November 14 and November 17, 1950, keeping in mind the need for equal distribution. Another was installed on December 5, 1950 and six more were installed on February 11, 1951.

In addition, a small tree trap, baited with suet, was installed to lure the smaller, unwanted birds from the Cardinal traps at Station 1. Two ground, funnel opening traps were installed, a small one on October 10, 1950 and a large one (see Figure 3) on December 3, 1950.

Relocation of stations was necessary in two instances. After the complete failure of Station 4 in its original location, it was moved on December 8, 1950 to an area which proved immediately successful. Station 3 was not producing much so it was relocated on December 31, 1950 bearing the designation "3A" and became active immediately.

As deemed necessary, cleaning of station areas or relocation of traps within the stations was accomplished in order to relieve possibilities of contamination. These operations were necessary because of a program of small rodent control in which poisoned seeds were placed under inverted cigar boxes.

FIG. 2. Trip-step Trap (Side View)

FIG. 3. Large Funnel Ground Trap

The bait used to lure the birds into traps was a wild bird seed mixture occasionally bolstered by walnut meats, pecans and uncracked corn. The mixture consisted of sunflower, *Helianthus annus*, peanut hearts, *Arachis hypogaea*, yellow, and red millet, *Panicum miliaceum*, hulled oats, *Avena sativa*, canary, *Canariensis sp.*, Milo maize, *Sorghum vulgari*, buckwheat, *Fagopyrum vulgare*, and wheat, *Triticum aestivum*. The lure had to be strong because of a great abundance of natural food including many weed seeds, pokeberries, beechnuts, wild grapes, yellow poplar seeds, and a domestic grape vineyard.

The proper placement of baits within the traps, with little encouraging outside bait, was a problem slowly recognized. The trick of baiting open traps at intervals, allowing easy escape of feeding birds, was also slowly understood as a means of alleviating the trap shyness of Cardinals.

Trap covers and bait platforms within the traps were finally recognized as an aid to unfrozen door hinges, drier bait, and the capture of more birds. An additional aid to surer capture was the placement of a few seeds on the trip-steps, rather than solely in the bait compartment, to eliminate the Cardinal habit of hopping over the trip-step. Several Cardinals were observed hopping over the trip-step so increases in the size of the trip-step and decreases in the bait compartment were made in all trip-step traps. The trap covers, and sure-catch devices were not installed until late January, 1951.

A method of securing traps in order to discourage cats and dogs was finally discovered in February, 1951 but was not too effective as long as the traps remained on the ground.

The problem was slow in developing for many reasons. Predator control was not very effective and placement of stations resulted in many interruptions by humans and animals among which the worst offenders were dogs, cats, hawks, owls, foxes and skunks in order. The worst effects were made by the ravages of stray dogs at the stations.

The unusually late and warm fall of 1950, coupled with the great abundance of natural food, served to delay progress, while the late start and failures of early station locations further delayed the capture of enough Cardinals to ensure a fair representation for study.

Competition from other species was heavy due to the unusual number of wintering White-throated Sparrows, *Zonotrichia albicollis* (Gmelin), Mississippi Song Sparrows, *Melospiza melodia euphonia* Wetmore, and Slate-colored Juncos, *Junco hyemalis hyemalis* (Linnaeus).

Weather effects, such as warm spells, produced great lapses in Cardinal captures as did the discontinuous trapping due to vacations, station repairs and relocations and particularly the deep snow of late November and early December of 1950. Freezing cold and snow, which carpeted the ground with a coating impenetrable to the Cardinal forced the birds to feed at the stations despite a recent predator fright. See Figure 4.

During most of the season Stations 1 and 3 were inactive much of the time and orchard operations such as clearing, thinning, application of fertilizer and other activities near stations had a bad effect on the number of captures. Hunting season was appreciably interruptive to capture success.

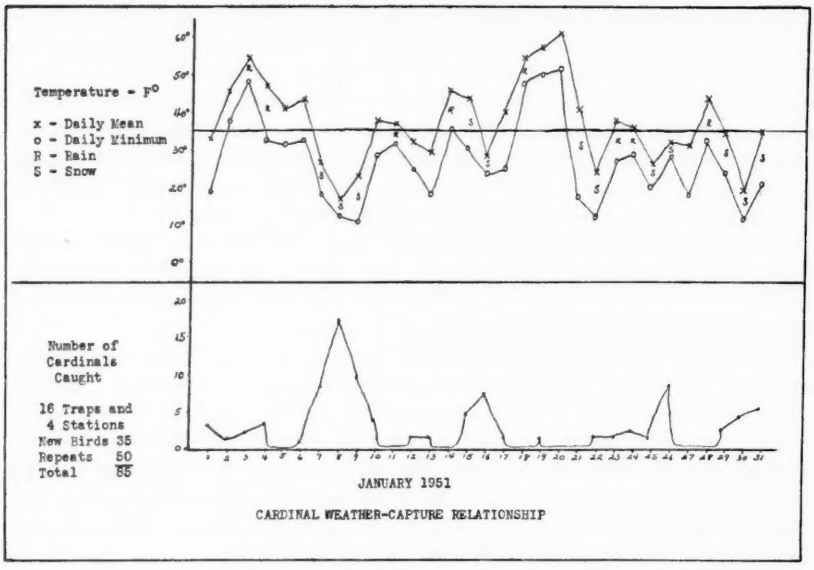

FIG. 4.

Prolonged spring inactivity and severe predation at Stations 3A and 4 prompted complete removal of traps to be included at Stations 2 and 1 respectively.

Each bird was assigned a consecutive number as caught. See Tables 5 and 13.

VII. FIRST WINTER OPERATIONS AND RESULTS

Each station was given a number and a color. The color referred to the color of the band to be placed on the right tarsi of all Cardinals banded at a particular station. Red was designated for Station 1; gold for Station 2; green for Stations 3 and 3A; and blue for Station 4. The color bands were used for field identification, with binoculars, in plotting the travels of the birds. Serially numbered federal bands placed on the left leg of the birds identified the individual upon recapture. Size 2 band used originally was changed to size 1A on November 18, 1950. See Figure 5.

Since the first Cardinal was caught November 5, 1950, the important early fall local movements were unrecorded in 1950.

The routine of banding consisted of two or three rounds to the stations daily. The last round, after dark, was considered necessary in order to free all captive birds and to reset and rebait all traps for the following morning, since the Cardinal is an early morning and a late evening feeder. A check on the repeat data of birds banded and released after dark proved that over half of the birds repeated later, thus alleviating fears of possibility of night mortality. When snow covered

the ground, as many daylight trips were made as possible in order to band birds, and clear and reset traps for greater numbers of captures.

Since the color bands were impractical for field identification due to the birds habit of perching with feet drawn up under the abdominal contour feathers, and the inability of the observer to see bands covered by grass or leaves on the ground, the only records of value were those few birds that were actually recaptured at another station.

The first Cardinal repeat occurred on November 21, 1950, but as the total built up, many repeats occurred. The earliest distinctive recapture was on December 8, but involved a move of only .3 miles by an immature male bird, #6. The latest, a significant repeat, was on January 15, involving bird #43 in a .75 mile move.

FIG. 5. Banded Cardinal

The only recoveries (see Table 2) involved #23, an adult female, from a total of four banded at Station 3 by December 15, 1950, which moved 1.3 miles from Station 3 to Station 4 on December 18, 1950 and back to Station 3 on December 31, 1950, and #32, an adult male, from a total of 17 banded at Station 4 by December 17, 1951, which moved 1.2 miles from Station 4 to Station 2 on January 7, 1951. The moves indicated a southwest to northeast avenue of travel and a comparative high percentage of travel among study Cardinals.

One unidentified gold banded male from Station 2 was observed by Mr. Brooks at his feeding shelf on April 17, 1951. This move involved a distance of .75 miles to the northwest and indicated that the spring dispersal was in progress. The dates involving winter records of recoveries and significant repeats were December 6, 1950 through January 15, 1951. This may indicate a critical period. Of the eight Cardinals involved in recorded moves, four were adult females, three were adult males and one was an immature male.

Five of the Cardinals were involved in moves of only .3 miles which indicated only that these birds moved at least that far in *daily feeding range*. One bird

TABLE 2

Records of Significant Moves and Recoveries

1950–51

BIRD NO.	AGE	SEX	ORIG. DATE	MOVES		ORIG. STA.	DIR.	STA.	DIR.	STA.	DIR.	STA.	DIS.
				Early	Late								
6	I	M	12–6	12–8	1–7	3	S	2	N	3	S	2	.3 mi.
7	A	F	12–6	12–15	12–18	3	S	2	—	—	—	—	.3 mi.
23	A	F	12–15	12–18	12–31	3	SW	4	NE	3	—	—	1.3 mi.
26	A	M	12–16	12–16	12–16	3	S	2	—	—	—	—	.3 mi.
27	A	F	12–16	12–17	1–8	3	S	2	N	3	S	2	.3 mi.
32	A	M	12–17	1–7	1–7	4	NE	2	—	—	—	—	1.2 mi.
37	A	F	12–19	1–1	1–1	3	S	2	—	—	—	—	.3 mi.
43	A	M	1–1	1–8	1–15	3A	SE	2	NW	3A	—	—	.75 mi.
?		M	?	4–17		2	NW	3A	—	—	—	—	.75 mi.

\#26, an adult male, was captured at Station 3 in the morning of December 16, 1950 and was recaptured at Station 2, or .3 miles distant, in the afternoon of the same day. Seven banding records corroborate the daily feeding range. See Table 2.

Field observations of banded birds disclosed no unusual records of distance, but revealed that five birds had removed colored or federal bands. The colored bands used at first were size 2 and some evidence of crimping was disclosed. However, some of the bands had been removed as evidenced by observations and retraps. Thus size 1A bands were put into use. Several badly crimped bands were removed and reshaped and the birds were rebanded, but on two occasions larger size 2 bands replaced the small crimped bands because of swellings on the birds' legs. Two known cases of federal band removal and three cases of colored band removal were recorded. A remedy for crimping and band consciousness was found in the manner of holding the Cardinal so it could not see the actual banding operation. Some birds were naturally band conscious but not enough to destroy fair representation.

Four cases of mortality due to cats and dogs arose, but of the two known banded birds involved neither was identifiable as the colored bands only were found.

Of the 100 Cardinals, 52 males and 48 females, caught between November 5, 1950 and April 20, 1951, 50 repeated. Of the 23 male repeats 13 were adults and nine were immatures. Of the 27 female repeats 22 were adults and five were immatures. Of the 13 immature males nine repeated and of the 35 adult males only 14 repeated. This would indicate that *adult males* were more independent and *wandered more*. Of the 42 adult females, 22 repeated. This indicates a higher *sedentary condition* of the *adult females* as compared to males. See Table 3.

The fact that any recoveries occurred suggests that a greater number of birds travelled equal distances, or even farther, but were not observed. By the laws of chance it would appear very impractical to hope that a Cardinal would wander a mile from a small, well-stocked feeding station, in one of many possible direc-

TABLE 3

Sexes and Ages of Marked Cardinals

Repeat Data

1950–51

	ORIGINALS	REPEATS
Males Banded	48	23
Adult	35	14
Immature	13	9
Females Banded	52	27
Adult	42	22
Immature	10	5

tions, and be recaptured in an area of 25 square feet in one of only five traps in the area. The odds were highly against such an occurrence, however it happened more than once and strongly indicated that some Cardinals, both males and females, are not so sedentary in winter.

The number of Cardinals caught at each station did not clearly indicate the *favoritism* of a *domestic habitat* in the presence of severe winter. Station 4 produced 30 Cardinals in three months. Station 1 produced 22 Cardinals in five months and Stations 2 and 3 (3A included), strictly interurban localities, produced 22 and 26 Cardinals in five months. It is possible that these facts may be explained by the necessity of the birds to move into the domestic scene during the 41 inch snow of November and early December, 1950. See Table 4.

The fact that Station 1 was highly inactive, in comparison to all other stations, most of the winter and then from *March 10* to *April 20, 1951 became very active producing* many *new Cardinals*, indicated the presence of transient birds, mostly males, in the spring. Simultaneously Stations 2, 3 and 4 were either inactive or completely closed due to severe predation. See Table 5.

Further perusal of the record (see Table 5) showed that sixteen of 33 adult females caught from December 15, 1950 to April 18, 1951 repeated at least once.

TABLE 4

Cardinal Sexes, Ages and Station Occurrence

1950–51

	MALES	FE-MALES	TOTAL	IMM. MALES	IMM. FE-MALES	TOTAL
Sta. 1	11	11	22	5	1	6
Sta. 2	12	10	22	0	2	2
Sta. 3	3	8	11	1	1	2
Sta. 3A	7	8	15	3	2	5
Sta. 4	15	15	30	4	4	8
Totals	48	52	100	13	10	23

TABLE 5

Individual Records of Cardinals Banded During the Winter Season 1950–51

A—Adult
I—Immature
Juv—Nestling
F—Female
M—Male
O—Photo
P—Paint
R—Repeat (Same Station)
Re—Return (Over 3 months)
Rec—Recovery (Over 1 mile)
Ret—Return (Over 6 months)
SR—Significant Repeat
TR—Repeat (Continuous)
(1), (2), (3) or (4)—Indicates Station Change

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
1	A	M	3	11–5–50	
2	I	F	3	11–11–50	
3	A	F	1	11–11–50	R 12–15, R 1–26, R 1–29, R 1–30, R 2–7, R 2–9, R 3–10, R 3–21, R 5–2
4	A	M	1	11–14–50	R 11–21, R 12–16, R 12–18, R 1–9
5	A	F	3	11–18–50	R 12–17, R 12–18, R 12–19, R 12–19
6	I	M	3	12–6–50	SR (2) 12–8, R 12–11, SR (3) 12–12, R 12–14, R 12–16, R 12–16, R 12–17, R 12–18, SR (2) 1–7, R 1–9, R 1–16
7	A	F	3	12–6–50	R 12–15, SR (2) 12–18
8	A	M	2	12–9–50	
9	I	F	4	12–10–50	
10	A	M	4	12–11–50	R 12–15
11	A	M	4	12–11–50	R 12–15
12	A	M	2	12–11–50	R 12–18, R 1–8, R 3–5, R 3–9, R 3–9, R 3–21, TR 5–6
13	I	M	4	12–11–50	R 12–12, R 1–26, R 1–30
14	A	F	2	12–12–50	R 12–8, R 1–1, R 1–15
15	A	F	4	12–12–50	R 12–15, R 1–25, R 2–10
16	A	F	1	12–13–50	
17	A	M	1	12–13–50	
18	A	M	4	12–14–50	R 12–19, R 1–31, R 2–2
19	A	M	2	12–14–50	
20	A	F	3	12–15–50	R 1–22
21	A	M	4	12–15–50	
22	A	F	3	12–15–50	R 12–16, (Rec, Ret (4) 9–25)
23	A	F	3	12–15–50	Rec (4) 12–18, R 12–18, R 12–19, Rec (3) 12–31, (Rec, Ret (4) 11–18)
24	A	M	1	12–15–50	
25	A	F	4	12–16–50	R 12–18, R 12–18
26	A	M	3	12–16–50	SR (2) 12–16
27	A	F	3	12–16–50	SR (2) 12–17, R 12–18, SR (3) 12–19, SR (2) 1–8, R 1–9, R 1–9
29	A	M	2	12–17–50	
30	A	F	4	12–17–50	R 12–18, R 12–19, R 12–19
31	A	F	2	12–17–50	
32	A	M	4	12–17–50	Rec (2) 1–7
33	I	M	4	12–17–50	R 2–8
34	A	M	2	12–18–50	R 12–19
35	A	F	3	12–18–50	Ret, SR (2) 11–25
36	I	F	2	12–19–50	R 1–9

TABLE 5—*Continued*

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
37	A	F	3	12–19–50	SR (2) 1–1, R 1–17
38	A	F	2	12–30–50	R 1–8, R 1–16, R 1–26, R 2–7, R 3–14, TR 5–6
39	A	M	2	12–31–50	Ret 12–12–51
40	A	M	4	12–31–50	R 1–9, R 1–10, R 1–16, R 1–31, (See #60)
41	A	F	4	12–31–50	R 1–4
42	A	F	4	12–31–50	
43	A	M	3A	1–1–51	SR (2) 1–8, SR (3A) 1–15, (P, Ret, SR (3) 10–7, SR (2) 12–14)
44	A	F	4	1–2–51	
45	A	F	2	1–3–51	
46	A	M	4	1–3–51	
47	A	F	2	1–4–51	
48	A	M	4	1–4–51	
49	A	F	4	1–7–51	
50	A	F	3A	1–7–51	R 1–8, R 2–2, R 2–7, R 2–8, R 2–9, R 2–10
51	A	M	3A	1–7–51	R 1–15, R 2–5 (P, Ret 11–24, R 12–10)
52	I	F	2	1–7–51	
53	A	M	2	1–7–51	R 1–8, R 1–9, R 1–26, R 1–31, R 2–2
54	I	F	4	1–7–51	R 2–9
55	I	M	3A	1–8–51	R 1–9
56	A	F	3A	1–8–51	R 1–8, R 1–30, R 2–1 (Ret 11–26–51, R 12–12) (See #75)
57	A	F	2	1–8–51	(Rec, Ret, P (4) 11–19–51)
58	A	M	4	1–8–51	R 1–13, R 2–7
59	A	F	4	1–8–51	
60	A	F	4	1–8–51	R 1–16, R 1–31, R 2–9 (See #40)
61	I	M	3A	1–8–51	
62	I	M	3A	1–8–51	R 1–12, R 1–24, R 2–10, R 2–11
63	A	F	3A	1–8–51	
64	A	M	2	1–8–51	R 1–16
65	A	F	2	1–9–51	
66	A	M	1	1–9–51	
67	A	M	2	1–10–51	(Ret 12–14–51)
68	A	M	3A	1–15–51	R 1–16, R 1–24, R 1–26, R 2–2, R 2–11
69	A	M	2	1–16–51	
70	A	M	2	1–19–51	
71	A	M	4	1–23–51	
72	A	M	4	1–26–51	
73	A	M	1	1–26–51	
74	A	F	3A	1–26–51	
75	A	M	3A	1–29–51	R 2–5, R 2–8, R 2–9 (Ret 11–26–51, R 12–12) (See #56)
76	A	M	2	1–30–51	R 3–31
77	A	F	1	1–31–51	R 2–2
78	I	M	4	2–2–51	
79	I	M	4	2–2–51	
80	I	F	4	2–3–51	R 2–7
81	A	F	4	2–4–51	R 2–8, R 2–9

TABLE 5—*Concluded*

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
82	I	M	1	2-4-51	R 2-5, R 2-7, R 2-9, R 3-13, R 3-21, R 3-21, R 4-5, R 4-17, R 4-19, R 5-2
83	A	F	3A	2-5-51	
28	A	F	3A	2-7-51	R 2-9
84	I	F	3A	2-7-51	R 2-8
85	I	M	1	2-8-51	R 2-10, R 3-15
86	A	F	1	2-9-51	R 3-16, R 3-21
87	I	F	1	2-9-51	
88	I	F	3A	2-14-51	
89	I	M	1	2-24-51	
90	I	F	4	3-5-51	R 3-7, R 3-15
91	A	F	1	3-10-51	
92	I	M	1	3-14-51	R 3-16
93	A	F	1	3-15-51	
94	I	M	1	3-21-51	R 3-26
95	A	F	2	4-2-51	
96	A	M	1	4-5-51	
97	A	F	1	4-7-51	
98	A	F	1	4-17-51	
99	A	F	3	4-18-51	R 4-19
100	A	F	1	4-20-51	
101	Juv		3	5-21-51	
102	Juv		3	5-21-51	
103	Juv		3	5-21-51	
104	Juv		3A	6-2-51	
105	Juv		3A	6-2-51	

In comparison, five of six *adult females* caught from November 11 through December 14 repeated and a *very stationary* condition existed among these birds in early winter but ceased in mid-January when travelling was indicated. The later banded females did not repeat after mid-February.

Of 11 *adult males* captured from November 5, 1950 through December 15, 1950 only five repeated. Only one of these, ♯12, could be considered sedentary with seven repeats through May 6, 1951. Two others repeated three and four times but were not recorded after February 2, 1951, and two others repeated once within four days and were not later recorded. These records indicate a general restlessness among *adult males*.

Of 24 *adult males* captured after December 15, 1950, 12 repeated but five repeated only once shortly after original capture. Number 40 repeated four times until January 31, 1951 and was seen and captured with ♯60, an adult female, indicating stationary range. Number 43 moved around between Station 2 and Station 3A as a significant repeat for only two weeks. Number 51 repeated twice from January 7 to February 5 but was indicated as static during the second winter. Number 53 repeated five times in one month, January 7 to February 2, and was not later recorded. Number 68 repeated five times in less than a month, January 15 to February 11. Number 75 repeated three times, January 29 until

February 9, and left. All of these records indicate a definite break up of any possible stationary condition by mid-February. Between January 9 and January 26 all new birds caught were adult males (numbers 66 to 73 inclusive). This would indicate a general shift of territory by adult males after mid-aggregation period.

Of 13 *immature males* banded during the year nine repeated. Number 82, captured February 4, 1951, repeated 10 times until May 2, 1951 and was unsettled during the early winter but static later. All other repeats were static until February 11 and then dispersed, except two caught February 8 or later which repeated once each until mid-March. These records again *indicate* a sedentary fall and aggregation period.

Of 10 *immature females* banded during the year five repeated and all five repeated once or twice during a month's time and then dispersed. The dispersal was in effect in all cases (except one) by February 11. The exception was #90 which was banded on March 5, repeated twice until March 15 and then dispersed. These records indicate a *highly unsettled state* among the *immature females* or a particularly strong fear and shyness.

Of nine adult females captured between November 11 and December 15, eight, repeated. One, #3, was particularly static and repeated nine times until May 2, 1951. One, #23, had a wider range, being recovered and repeating three times at Station 4 and returning to Station 3 within two weeks time, but was still *fairly* static. The other six repeats dispersed by February but averaged three repeats each.

Of the 33 adult females captured after December 15 only 14 repeated. Number 38, caught on December 30, 1950, repeated six times through May 6, 1951. All other repeats in this category indicated a *temporary sedentary period* until February 11 or, as in the case of #27, made significant repeats between Stations 2 and 3 from December 16, 1950 to January 9, 1951 and then dispersed.

In summary, on a comparative basis the *adult females* were in a quite *unsettled condition after February 9* but were *very sedentary* in *early winter* distribution.

Adult males were generally restless early and late and were *temporarily sedentary* in mid-winter until a *striking major shift* occurred in *mid-January.*

Immature males showed a *high sedentary* state during the *entire winter season.*

Adult females showed an early strong *sedentary* condition and a *slower* general dispersal from the aggregation. They showed no major shift tendency as did the adult males.

Immature females were low in abundance and showed a definite *unsettled condition* throughout the season.

The 48-non-repeat Cardinals (18 adult males, 4 immature males, 5 immature females, 21 adult females) add only to the already high percentage of winter restlessness.

Additional *sedentary indications* and winter pairing of adults were noticed in the fidelity shown by #40, adult male, and #60, adult female, at Station 4. These two birds were caught together on three different occasions. At Station 1

an adult male and an adult female were caught together and often adult males were observed waiting close to captured females. At Station 2, #12, an adult male, and #38, an adult female, were captured together on May 6, 1950.

An indication of the competition the Cardinals had from other bird species is obvious due to the fact that nine other species were banded during the first season and that many English Sparrows, *Passer domesticus domesticus* (Linnaeus), were caught. The birds banded, other than Cardinals, and not including many repeats, totaled 299 individuals.

An aggregation of 40 or more Cardinals was observed on several days in January, 1951 and on February 4, 1951 in the vicinity of Station 2. By February 19, 1951, with warmer and longer days accompanied by pre-mating singing and chasing, the aggregation in the area had broken down into small groups with a noted decrease of females accompanying the break down.

Pre-mating action began with singing and chasing, and feeding competition among the males on February 9, 1951. By March 3, 1951 the aggregations dissolved and strong mating activity such as singing of females, and female manipulation of nesting material were observed on March 27, 1951. The nesting territory competition between males was constant beginning April 7, 1951.

The theory that Cardinals are apt to travel parallel to ridges and valleys and are not apt to cross ridges was not indicated. The only long distance records established in December and January made use of a wooded ravine with wooded slopes running in a southwest-northeast direction from Station 4 to Stations 2 and 3. The cross-ridge move involved Stations 2 and 3A and yet was only a .75 mile move over a fairly flat area.

Records of the original captures, repeats and returns of individual birds were made at the traps and transferred to record sheets each day.

Banding and field observation consumed 576 hours minimum during the first winter season.

VIII. SUMMER NESTING AND PREPARATION PERIOD

Twenty-four nests were found within one-fourth mile radii of Stations 2 and 3A and within a radius of one-half mile in Falling Run Valley between May 3, 1951 and May 9, 1951.

The plan was to band the nestlings in order to determine their immediate range while they were still immature and possibly to determine fall and winter dispersal.

The nesting sites chosen by the Cardinal involved the following plants: grapevine, spruce, *Picea sp.*, smilax, hawthorn, apple, wild cherry, honeysuckle, poison ivy tangle on stump, and domestic shrubs.

All nests near banding stations involved banded birds. At nest #5 the female had a green band. At nest #17 the female had a red band. At nest #25 the male had a red band. At nest #23 the male bird, #75, was recognizable from a bill deformity and had a green band.

From the 25 nests, only five young were banded. Nest failures were attributed to desertion before eggs were laid in 13 cases, with cause of desertion unknown.

Cowbird parasitism or puncturing led to three desertions or failures. Catbird interference led to two desertions. Human interference led to three failures. Four nests were partially successful with six nestlings from two nests unaccounted for, but thought to have been seen later under parental care.

The impracticality of hoping to secure results from nestling banding of Cardinals cannot be too strongly stressed. As a result, the five nestlings banded (See Table 5) were not included in the total of study birds.

After the attempt was made to band nestlings and to observe banded birds, preparations for the second winter were started. Sporadic observations failed to disclose any unusual records of marked birds.

First consideration was given to re-establishing stations. Station 1 was permanently discontinued when observation proved the area had been cleared of all protection and roosting cover and that a new family with three small children and a large spaniel had occupied the adjacent property.

FIG. 6. Station 2

Station 2 was gradually re-established in its original location underneath the protection of an apple tree which was covered by a heavily laden wild grape vine. A table was moved into the station and bait was consistently left on it beginning August 10, 1951. The station was finally established on October 8, 1951 with a raised platform. See Figure 6.

Station 3 was protected on three sides by a heavy brush fence and a wire fence was installed as an inner lining in order to discourage animal predators. A three and a half foot platform was installed and bait was intermittently left beginning August 10, 1951. The traps were installed on September 18, 1951.

Station 3A was not reconditioned but, since there was a sunflower planting of large proportions nearby, the old station site was held in readiness for possible inactivity at Station 3. Station 3A was re-established on November 6, 1951 with a raised platform and six traps.

Station 4 was not established until September 18, 1951 due to the presence of a late nest of Wood Thrushes, *Hylocichla mustelina* (Gmelin) on the spot, but

bait was left at the station, on the ground, from August 10, 1951. On September 21, 1951 the station was actually established with a raised platform and seven traps.

Other preparations for the second season included reconditioning and painting the traps. A dull finish black paint was used to facilitate easier sight of the bait by the birds. Devices were installed on all traps for the purpose of holding them open when not in use in order to let the birds become accustomed to entering and leaving at will. All of the wrap around traps were tightened and devices were added to secure them to the ground as protection against predators. Covers were obtained for all traps. The front edges of all trip-steps were raised so predators could not push in the doors of closed traps. The two large wrap around traps were reduced in size for easier operation.

A large crop of sunflowers was harvested in late September and was of great use in supplementing the wild bird seed with pecan meats, dried wild grapes and elderberries.

Another improvement near Station 2 was the construction of a back-water pond during the early summer by the University Dairy Farm. It provided water in an otherwise water-deficient area. There was still some water near Stations and 3 and 4. Since the beechnut crop failed and not too many tulip poplar seeds were in evidence, the successful wild grape and elderberry crops were helpful to the birds in the problem area. Many elderberries were gathered, dried and added to the early fall bait. Walnuts were gathered and stored for later use.

Late summer and early fall observations disclosed the presence of successful second and third broods of immature Cardinals, some still under parental care.

On August 11, 1951 during an observation in the vicinity of Station 4, adult male and female blue banded birds were observed.

As a result of the impracticality of using colored bands for field observation, model airplane dope in silver, yellow and sky blue colors was purchased for use in marking birds for clearer identification. A painting laboratory was set up in the entomology laboratory at the West Virginia University Horticultural Experiment Farm. The laboratory was finally used only for drying wet birds and the paints were moved to the pertinent stations. A system of marking was decided upon. At Station 2 yellow paint was applied in a square pattern at a median point on the upper surface of the central retrices, and spots on the under surface on the outer retrices. At Station 3 and 3A two horizontal silver bars were painted. Each was one half inch wide and was separated by one half inch unpainted upper surface at a median point. The under surface was marked on each outer retrice with two silver spots. At Station 4 a light blue vertical stripe the length of the two central upper retrices was used. The under surface showed vertical stripes on both outer retrices. As an example see Figure 7.

Painting proved to be impossible until all retrices were completely grown after molting. Most Cardinals did not complete the molt until the end of the third week in October except for a few late brood immatures which did not molt retrices.

The securing of color and black and white photographs accompanied the progress of the season.

Population counts in the vicinity of the stations were proposed at regular intervals. See Table 10.

IX. SECOND WINTER OPERATIONS AND RESULTS

On September 17, 1951 three stations were opened and the traps were placed and set with bait. Station 2 contained four trip-step traps fastened to the platform, three wrap around traps secured to the ground and one large funnel ground trap. See Figures 3 and 6. Station 3 had four trip-step traps on the platform, two wrap around traps secured to the ground and a small ground funnel trap. At Station 4 five trip-step traps were fastened to the platform, and two shortened wrap around traps were fastened to the ground. Station 3A was re-established on November 6, 1951 with four trip-step traps fastened on a platform three and a half feet high and two wrap around ground traps all moved from Station 3

FIG. 7. Field Mark Stations 3 and 3A.

On December 29, 1951 after a period of inactivity and predation trouble, Station 3A was discontinued. The four trip-step traps and platform were transferred to Station 4 and set up on December 31, 1951. The two wrap around ground traps were put out of use. Station 3 could not be re-established because of complete clearing operations at the site.

Transient Cardinals continued to appear from October through February. Some of these were captured and either repeated one to three times or completely disappeared. There were always "stranger" Cardinals around all station areas. The original distances and directions they had travelled are unknown and no hint of their later whereabouts was indicated.

During September, 1951 the number of captures was low due to the shyness of birds during the molting process and the fact that the stations had not been well established. Some immatures were still under parental care. There was some predator trouble and rodent interference. Five of the Cardinals captured were male immatures and one female immature was caught. The four adults were two males and two females. The two adult females were a return and a recovery. See Table 13. Only four of the 10 birds repeated. One adult male, **109*, repeated

six times and is considered to be a *static* bird for the *winter* at Station 2. Number 106 and ✱107, immature males, repeated six and 13 times respectively and *✱107* is considered to be *static* for the *winter*. *Number 112*, an immature female, was a significant repeat, being found at Station 2 originally and moving to Station 3 on October 7 and later to Station 3A on November 7, or definitely of *transient* character. Four of the 10 birds were subsequently painted but six were never recorded again.

Eighteen birds were captured during October, 1951. One of these, *✱43*, an adult male *return* from Station 3A, was painted and photographed and still repeated three times until January 7, 1952. His record showed him to have been *established* in a winter *territory* encompassing Stations 3A and 2 *both winters*. Of the other 17, nine were immatures, six females and three males. Three of the immature females repeated only once during the following 30 days and made no further appearance, an evidence of transient character. Two immature females were painted. Another immature female, *✱130*, banded and painted on October 28, repeated once each in November and December and not again until February. This bird could be considered *static*. Of the adult birds banded six unpainted birds were never again recorded while *✱122*, an *adult male*, and *✱129*, an *adult female*, repeated once and both were painted. *Number 122* did not return until January 30, 1952, at which time he was painted, showing a *transient* character. In all, 10 of the 18 birds were subsequently recorded.

Twelve birds were painted during September and October and these were not wholly representative. Four were males, one an adult female, and the other eight were immature females. Five were from Station 2 (only one male), four were from Station 4, all immature females, and three were from Stations 3 or 3A, all males. During concentrated banding operations, observations were confined to immediate station areas and only ✱107 was observed in the vicinity of Station 2. Fifteen of the 28 birds involved were immatures and eight of these repeated while only four of the 13 adults ever repeated. Only one bird, ✱22, an adult female from Station 1 on December, 1950, was a recovery and return at Station 4 on September 25, 1951.

November, the critical month of aggregation establishment

In November, 1951 aggregation establishment critical to Cardinal winter survival began. The Cardinal's need of locating roosting cover, after the deciduous leaves fell, was an apparent factor. The establishment of aggregations began at this time with location of food, water, protecting cover and roosting areas being of prime importance. At this time a great number of Cardinals moved in to roost in the pines and vines at the Horticultural Farm. Several of the probable in-transit birds ventured further to roost in the large vine tangles and hawthorn patches in the woods to the north and northeast. The immature birds were definitely put on their own resources at this time and competition was at its lowest ebb under the winter conditions. See Tables 7, 10 and 11.

November brought a general influx of Cardinals and 75 were painted. Of these, seven were returns from the first season indicating a *static winter range*

TABLE 6

Recovery Records among November, 1951 Captures

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	DIR.	STA.	DATE	DIR.	STA.	DATE	TIME INVOLVED
134	A	M	4	11-6-51	NR	2	12-21,	SW	4	1-2	54 days
138	I	F	3A	11-8-51	SW	4	12-12				34 days
139	I	F	3A	11-8-51	SW	4	11-12				4 days
152	I	F	4	11-10-51	NE	2	11-19				9 days
154	I	F	3A	11-10-51	SE	2	11-30,	SW	4	2-14	94 days
165	A	M	2	11-17-51	SW	4	1-2				

for at least seven per cent of *adult birds*. Six distance recoveries occurred among birds caught during November, 1951. These records involved dates between November 6, 1951 and February 14, 1952. See Table 6.

These records indicate an unsettled condition among immature females and adult males. Number 23, an adult female, and ♯57, an adult female, each put in one recovery appearance in mid-November. See Table 13. Number 23 had already made two recovery records during the first season thus indicating a restless individual character greatest among females. Number 134, an adult male, made two recovery records from Station 4 on November 6, 1951 to Station 2 on December 11, and back to Station 4 on January 2, 1952, indicating an individual unsettled range condition. An adult male, ♯164, moved from Station 2 into Station 4 on January 2, 1952 and stayed through March. A conclusion can be established that four of 16 banded immature female Cardinals travelled at least one mile during the months from November through February. The two adult males of the twelve adult males banded by November 17, 1951 recorded three recoveries involving months from November, 1951 to February, 1952. Application of these percentages to the total population would indicate a far greater number of distance moves than were actually recorded. The two adult female recoveries do not indicate a record for the second season but evidence an individual restlessness during both winter seasons.

During November there were seven returns from the first season's banding as follows:

TABLE 7

Returns of First Season Cardinals, November, 1951

BIRD NO.	AGE	SEX	STA.	LAST RECORD	STA.	DATE
23*	A	F	3	12-31-50	4	11-18-51
57*	A	F	2	1-8-51	4	11-19-51
51	A	M	3	2-5-51	3A	11-24-51
35	A	F	3	12-18-50	2	11-25-51
75	A	M	3A	2-9-51	3A	11-26-51
56	A	F	3A	2-1-51	3A	11-26-51
50	A	F	3A	2-10-51	3A	11-30-51

* Numbers 23 and 57 also made recovery records.

TABLE 8

Returns of First Season Birds in December, 1951

BIRD NO.	AGE	SEX	STA.	LAST RECORD	STA.	DATE
39	A	M	2	12-31-50	2	12-21-51
67	A	M	2	1-10-51	2	12-14-51
70	A	M	2	1-19-51	2	12-28-51

Banding had been continuous from September 17 until December 14, 1951, however, after a total of 100 Cardinals were painted on December 14, 1951, banding was sporadic. In December, 1951 only 23 new Cardinals were painted and banded. Three of the 23 were returns from the first season, all at Station 2, as recorded in Table 8.

Only nine of the 23 Cardinals were females, six being adults. Of the six adult females only three repeated and only one of these repeated significantly until February 8, 1952. Number 216, an adult female, repeated three times in January and once in February after having been originally banded on December 28, 1951. See Table 13. Only one of the three immature females repeated and it only once. Five adult males of the 10 caught repeated at least once and three of them repeated at least twice.

In January, 1952, 20 Cardinals were recorded including three returns from last year's banding. These three were obviously static in the general area in winter as they all returned and repeated later, as noted in Table 9.

Of the 20 Cardinals banded during January, 1952, 18 were painted and 11 repeated within 30 days. Several other repeat birds were repainted, since the paint had begun to wear off after two months. It was noticed that over 66% of the 20 birds were males.

Of the six new birds, five males and one adult female, or 83% males, banded in February in only two banding days, all were painted and one male repeated. The rest of the season was devoted to observation in the field and an accounting of the results follows.

In February a bad effect on the survival of the Cardinal aggregation in the vicinity of Station 2 was produced by the clearing of a large supplemental roost area adjacent to the pine grove roost. Immediately the Screech Owls, *Otus asio naevius* (Gmelin) began to disturb the concentrated roost population. This fact also induced a premature temporary decrease of the aggregation even though some pre-mating behavior had been observed at the same time. Later observation on February 23, 1952 proved that the aggregation was still intact but had

TABLE 9

Returns of First Season Cardinals, January, 1952

BIRD NO.	AGE	SEX	STA.	LAST RECORD	STA.	DATE
38	A	F	2	5-6-51	2	1-7-52
58	A	M	4	2-7-51	4	1-24-52
15	A	F	4	2-10-51	4	1-30-52

TABLE 10

Compiled Population Counts

1951–52

DATE	HOUR	LOCATION	DAILY TOTAL	
10–1–51	1 P.M.	Falling Run	Saw	12
	2 P.M.	Horticultural Farm	Heard	16
			Total	28
10–18–51	8 A.M.	Falling Run	Saw	29
	9 A.M.	Horticultural Farm	Heard	15
			Total	44
11–13–51	8 A.M.	Falling Run	Saw	35
	9 A.M.	Horticultural Farm	Heard	8
			Total	43
11–14–51	2 P.M.	Horticultural Farm	Saw	29
			Total	29
11–30–51	2 P.M.	Horticultural Farm (NE)	Saw	47
	3 P.M.	Station 2	Total	47
12–27–51	9 A.M.	Falling	Saw	33
	10 A.M.	Station 2	Heard	3
			Total	36
12–31–51	Christmas Bird Count	Falling Run and Horticultural Farm	Saw	75
			Total	75
1–12–52	2 P.M.	Station 2 and vicinity	Saw	84
			Total	84
2–23–52	2 P.M.	Station 2 and vicinity	Marked	18
			Unmarked	30
			Total	48
3–3–52	9 A.M.	Station 2 and vicinity	Saw	30
	12 N	Station 4 and vicinity	Saw	43
	2 P.M.	Lower Dairy Woods (NE)	Saw	41
			Total	114

TABLE 11

Second Season Repeat Data

69 Repeats of 132 Cardinals—52% Sept. 17, 1951 through Feb. 14, 1952

	REPEATS	CAPTURED	PERCENT
Immature Males	16	26	61
Adult Males	20	39	51
Immature Females	18	30	60
Adult Females	15	37	42
Total	69	132	52

partially shifted .5 of a mile north. The aggregation contained about 48 birds of which 18 were yellow painted.

The fact that only 16 of 100 first season Cardinals returned during the second season indicates a decided restless condition and a continuous change of local ranges. One indication of time and direction may be seen in the record of ✱22, an adult female, which was captured December 15, 1950, repeated once on December 18 and turned up during the molt, after nesting, at Station 4 over one mile north on September 25, 1951. The direction required crossing through a large part of the city, or going along the longer water route down Decker's Creek to the Monongahela River and then up Falling Run.

By March 15, 1952 a trend that was evident among adult males after January 20 was intensified. The appearance of unbanded and unmarked males and females, both definite transients, indicated an increase in population since the number of seasonally stationary marked birds remained the same in the vicinity. The comparison was made more evident by the courtship and pre-nesting antics of single males and pairs of birds at the stations.

The 16 adult birds which did return from the first season were equally males and females and, although three made recovery records of one mile in various directions, it indicates a continual shifting of population composed mostly of adult birds whereas the immature males, on the average, were more content and remained stationary during their first winter. There was no apparent established routine in these moves but control was probably set by availability of suitable roosts, wild food, water, shyness and weather conditions. Competition among Cardinals obviously took place in winter for both roost and feed territory, but in varying degrees.

Pressure was greatest in the feeding competition during the late aggregation period in January and February, 1952 when food supplies had dwindled.

X. LATE WINTER AND SPRING PHASES

SECOND SEASON

The last four days of banding operations on January 30, 1952, February 7, 8 and 14, 1952 produced 14 new Cardinals of which six were adult males, five were immature males, two were adult females and one was an immature female. This indicated the presence of a high number of transient males during the half-month period. During the same period the repeats at the two active banding stations involved 13 adult males, 12 immature males, 16 adult females and seven immature females. A comparison reveals that adult females were passive, males of both ages were highly passive except for an influx of strange in-transit Cardinals, and that immature females were considerably dispersed during the half-month period. The data indicate a period of oncoming restlessness effected by a decreasing food supply and longer days with warmer weather which affected the singing and competitive impulses of males.

During the warm weather in mid-March the dispersal of most of the passive Cardinals in banding station areas took place. The shift was conditioned by competition by males, and later, pairs of birds in declaration of nesting territory.

TABLE 12

10 Significant Recovery Records of the 1951–52 Season

BIRD NO.	AGE	SEX	RECORD DATE	DIR.	DIST.	TIME TAKEN
22	A	F	9–25–51	NW	1.0 mi.	9 mos.
139	I	F	11–12–51	SW	1.2 mi.	4 days
23	A	F	11–18–51	SW	1.3 mi.	11.5 mos.
57	A	F	11–19–51	SW	1.2 mi.	11.5 mos.
152	I	F	11–19–51	NE	1.2 mi.	9 days
138	I	F	12–12–51	SW	1.2 mi.	34 days
134	A	M	12–21–51	NE	1.2 mi.	45 days
134	A	M	1–2–52	SW	1.2 mi.	12 days
165	A	M	1–2–52	SW	1.2 mi.	31 days
154	I	F	2–14–52	SW	1.3 mi.	75 days

The largest group of Cardinals to be found on March 20 and 21, 1952 was composed of two females and three males and none of these was marked. Indications of the presence of strange Cardinals in banding station areas was definite since in each instance of observation a marked male or a marked pair was kept busy defending declared territory against strange, unmarked Cardinals.

After banding operations were discontinued in mid-February the balance of February and March was utilized for field observation.

A total of 26 observation stations were involved in the seareh for marked Cardinals. Each station was located in an area where from 5 to 40 Cardinals composed the probable aggregation populations and were at distances up to 3.5 miles from the nearest banding stations. Most of the Cardinals painted in November would still have been well marked after three months of wear and that fact, coupled with the absence of marked birds from banding station vicinities, indicated travels extending beyond the observer's limit of search. See Tables 12 and 13.

An estimated number of 285 Cardinals were observed at the 26 observation posts and the obvious scarcity of marked birds among the total indicates a very high concentration of local winter populations. A continuous shift of unmarked adult males and females or small groups of birds of both sexes took place during the season as indicated by the fact that new birds were caught each banding day throughout the season and only 52% of the total ever repeated at the stations.

Ten of 236, or 4.23% of the marked birds, produced banding recovery records in eight months total banding time during two seasons of banding. This is a high percentage considering the placement and number of stations, the number of traps and the size of the station areas. See Table 15.

XI. DISPERSAL-DISTRIBUTION PROGRESS

Painting the designs in color on the retrices of Cardinals could take place only rarely until late October when it was observed that all retrices had been replaced by the completion of molting. Prior description of designs used at each station has been made.

TABLE 13

Individual Records of Cardinals Captured During the Winter Season 1951–52

A—Adult
I—Immature
F—Female
M—Male
O—Photo
P—Paint
R—Repeat (Same Station)
Re—Return (Over 3 months)
Rec—Recovery (Over 1 mile)
Ret—Return (Over 6 months)
SR—Significant Repeat
TR—Repeat (Continuous)
(1), (2), (3) or (4)—Indicates Station Change

Dates in brackets Indicate Return Data

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
106	I	M	3	9–18–51	P, R 9–18, R 10–9, R 10–21, R 10–28, SR (2) 11–20, R 11–26
107	I	M	2	9–18–51	P, R 10–16, R 10–24, R 11–5, R 11–7, R 11–8, R 11–9, R 11–25, R 12–1, R 12–10, R 12–17, TR 1–10, TR 1–30, TR 2–7
99	A	F	3	9–20–51	Re from 4–18–51
108	I	M	4	9–24–51	
22	A	F	1	9–25–51	Rec, Ret (4) from Sta. 1 (12–18–50)
109	A	M	3	9–25–51	P, R 10–31, SR (2) 12–10, R 12–14, R 12–17, TF 1–10, TR 2–14
110	I	M	4	9–26–51	
111	I	M	3	9–29–51	
112	I	F	2	9–29–51	P, O, SR (3) 10–7, SR (3A) 11–7
113	A	M	3	9–29–51	
114	I	M	4	10–5–51	R 10–11
43	A	M	3A	10–7–51	(P, Ret 1–15–51), SR (2) 12–14, R 12–17, R 1–7, P, O
115	I	F	4	10–16–51	P, R 10–22
116	A	F	4	10–17–51	
117	A	F	4	10–19–51	
118	A	F	4	10–19–51	
119	A	M	4	10–19–51	
120	I	F	4	10–19–51	P, R 11–3, R 11–19
121	I	M	4	10–19–51	
122	A	M	4	10–20–51	P, Re 1–30
123	I	M	4	10–21–51	
124	I	F	4	10–22–51	P, R 10–24
125	I	F	4	10–23–51	P
126	A	M	4	10–25–51	
127	A	F	4	10–24–51	
128	I	F	2	10–27–51	P
129	A	F	2	10–27–51	P, R 11–1
130	I	F	2	10–28–51	P, R 11–3, R 12–14, TR 2–14
131	A	M	2	11–2–51	P, R 11–19, R 12–10, R 12–14, R 1–19
132	A	F	2	11–3–51	P
133	A	M	4	11–5–51	P
134	A	M	4	11–6–51	Rec (2) 12–21, Rec (4) 1–2
135	I	F	4	11–7–51	P, R 11–17
136	I	F	3A	11–7–51	P
137	I	F	4	11–8–51	P, R 1–30

TABLE 13—*Continued*

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
138	I	F	3A	11-8-51	P, Rec (4) 12-12, R (4) 12-14
139	I	F	3A	11-8-51	P, Rec (4) 11-12
140	A	M	3A	11-8-51	P, R 12-12
141	I	F	3A	11-8-51	P
142	I	F	3A	11-8-51	P, R 11-16, R 11-19, R 12-2
143	A	F	3A	11-8-51	P
144	A	F	3A	11-8-51	P
145	I	F	3A	11-8-51	P
146	A	F	4	11-9-51	P, R 12-12
147	I	M	3A	11-9-51	SR (2) 11-13, R (2) 11-16
148	A	F	3A	11-9-51	P, R 11-14, SR (2) 11-19, R (2) 12-11, R (2) 1-10, R (2) 1-24, R (2) 2-7
149	I	F	3A	11-9-51	P, R 11-20, R 11-20, R 11-23, R 11-25, R 11-26
150	I	M	3A	11-9-51	P, R 12-10
151	A	M	4	11-10-51	P, R 12-2, TR 2-14
152	I	F	4	11-10-51	P, Rec (2) 11-19
153	I	F	4	11-10-51	P
154	I	F	3A	11-10-51	P, Sr (2) 11-30, Rec (4) 2-14, (TR)
155	I	M	2	11-10-51	P, R 11-18, R 11-19, R 12-5, R 12-9, R 12-12, R 1-7, R 1-10, R 1-30
156	A	F	3A	11-12-51	P
157	I	M	2	11-12-51	P, R 11-14, R 11-17, R 11-17, R 11-24, R 12-12, R 12-14, R 12-28, R 1-24, R 1-25, R 1-30, TR 2-14, Retrices picked off
158	I	F	4	11-13-51	P, R 1-30
159	I	M	2	11-13-51	P, R 11-19, R 12-9, R 12-10, R 12-12, R 1-7, R 1-10, R 1-30, R 2-7, TR 2-14
160	A	F	4	11-13-51	P, R 11-30, R 12-12
161	A	M	3A	11-14-51	P
162	A	F	4	11-14-51	P
163	I	F	2	11-15-51	P
164	I	M	2	11-15-51	P, R 12-15, R 12-19
165	A	M	2	11-17-51	P, R 11-19, R 12-1, Rec (4) 1-2-52, R (4) 1-5, R (4) 1-24, R (4) 2-8
166	A	F	2	11-17-51	P, R 12-11, R 12-14, R 1-24, R 1-25
167	A	F	2	11-18-51	P, R 11-19, R 11-25
168	A	M	2	11-18-51	P
23	A	F	3	11-18-51	P, Rec (4) 11-18, band replaced, Ret (3) (12-31-50)
169	A	M	4	11-18-51	P
170	A	F	4	11-18-51	P
171	A	F	2	11-19-51	P
57	A	F	2	11-19-51	P (Blue), Rec (4) 11-10, Ret (2) (1-8-51)
172	A	F	2	11-19-51	P, R 12-6
173	A	F	2	11-20-51	P
174	A	F	2	11-20-51	P, R 1-30, R 2-7
175	A	F	3A	11-20-51	P
176	A	M	4	11-21-51	P, O, R 11-25, R 1-2
177	I	F	2	11-21-51	P, O, R 11-27, R 12-14, R 12-19, R 1-7, R 1-25, R 1-30, R 2-7

TABLE 13—*Continued*

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
178	I	F	2	11-21-51	P, O
179	I	F	4	11-23-51	P
180	A	F	2	11-24-51	P, R 12-19, R 12-12, R 12-14, R 1-30, R 2-14
181	A	M	3A	11-24-51	P, R 12-2, SR (2) 1-30
51	A	M	3A	11-24-51	P, SR, Ret (3) (2-5-51), R (2) 12-10
182	I	M	2	11-25-51	P, R 11-20, R 1-7
183	A	M	4	11-25-51	P, R 12-2, R 12-28, R 1-24
184	A	M	4	11-25-51	P
35	A	F	3	11-25-51	P (Yellow), SR (2), Ret (3) (12-18-50), R (2) 12-19, R (2) 1-30
185	A	F	2	11-25-51	P, R 11-28, R 11-30, R 12-2, R 12-3, R 1-30, R 2-7, R 2-14
186	A	F	2	11-25-51	P
187	I	M	4	11-26-51	P
188	A	F	2	11-26-51	P, R 11-27, R 12-17, R 12-19, R 12-19, R 1-25, R 1-30, R 2-7
75	A	M	3A	11-26-51	P, Ret (2-9-51), R 12-12
86	A	F	3A	11-26-51	P, Ret (2-1-51), R 12-12
189	I	F	2	11-27-51	P, R 12-1, R 12-1, R 12-3
190	A	M	4	11-27-51	P
191	I	M	4	11-27-51	P
192	A	F	4	11-27-51	P
193	A	M	4	11-27-51	P, R 1-30
194	A	F	2	11-28-51	P, R 12-12
195	A	F	2	11-28-51	P
196	A	F	2	11-28-51	P
197	A	M	2	11-28-51	P
50	A	F	3A	11-30-51	P, Ret (2-10-51)
198	I	M	2	11-30-51	P, R 12-4, R 12-10, R 12-12
199	I	F	2	12-2-51	P
200	I	M	4	12-3-51	P
201	A	F	2	12-5-51	P, R 12-9
202	A	M	3A	12-5-51	P, R 12-11
203	I	M	4	12-6-51	P, R 12-28
204	A	F	4	12-9-51	P
205	A	M	2	12-10-51	P, R 1-10, R 1-30
206	A	M	3A	12-11-51	P
207	A	F	2	12-11-51	P, R 12-14
208	I	M	4	12-12-51	P
39	A	M	2	12-12-51	P, Ret (12-31-50), new band
209	I	F	2	12-12-51	P
210	A	M	4	12-14-51	P
211	I	F	2	12-14-51	P, R 12-17
212	A	M	2	12-14-51	P, R 12-28
67	A	M	2	12-14-51	Ret (1-10-51), R 12-19, R 12-21
213	A	M	2	12-14-51	
214	I	M	4	12-21-51	
215	A	F	2	12-21-51	
216	A	F	4	12-28-51	R 1-10, P, R 1-24, R 1-30, R 2-8

TABLE 13—*Concluded*

BIRD NO.	AGE	SEX	STA.	ORIG. DATE	RECORD
70	A	M	2	12-28-51	Ret (1-19-51)
217	A	F	4	12-28-51	
218	A	M	4	12-28-51	P, R 1-2, R 1-10, R 1-30
219	A	M	4	1-2-52	
220	A	M	4	1-5-52	P, R 2-8
38	A	F	2	1-7-52	Ret (5-6-51), R 2-7
221	I	M	4	1-10-52	P, R 1-24
222	I	F	2	1-19-52	P, R 2-14
223	I	M	4	1-19-52	P, R 1-30, R 2-14
224	A	M	2	1-24-52	P, R 1-30
58	A	M	4	1-24-52	P, Ret (2-7-51), R 2-6
225	A	M	4	1-24-52	P, R 1-30
226	A	F	4	1-24-52	P
227	A	M	2	1-25-52	P, R 2-14
15	A	F	4	1-30-52	P, Ret (2-10-51), R 2-8
228	A	M	4	1-30-52	P
229	A	M	2	1-30-52	P
230	A	M	2	1-30-52	P
231	A	M	2	1-30-52	P
232	I	M	2	1-30-52	P
233	A	M	4	1-30-52	P, R 2-14
234	I	F	4	1-30-52	P
235	A	F	4	1-30-52	P
236	I	M	2	2-7-52	P, R 2-14
237	A	M	2	2-7-52	P
238	I	M	2	2-14-52	P
239	A	F	2	2-14-52	P
240	I	M	4	2-14-52	P
241	I	M	2	2-14-52	P

The designs were found to be short-lived, particularly in the case of the silver dope which, because of its metallic flakiness, wore off within two months. An example, ♯154 caught at Station 3A on November 10, 1951 was a significant repeat at Station 2 on November 30, 1951 at which time the dope was in fairly good condition. However, when the bird was seen at Station 4 on February 13, 1952 the green band was intact but the marking was not discernible with the aid of binoculars. Upon recapture of the bird the next day the retrices showed traces of silver bars. Retouching at Station 3A was carried out until December 12, 1951 when the station was discontinued. The presence of several obvious silver-barred Cardinals near Station 3A during early March indicated that retouching must have been a successful venture.

Several recaptured birds at Stations 2 and 4 were retouched beginning on January 25, 1952 in order to enhance future field observation. This process was continued until February 14, 1952 when it was stopped on the basis of possible interference of nesting by color conscious females in the near future.

Only three recaptured birds were known to have broken off painted retrices

but other evidences of consciousness, among females in particular, were observed and divulged partial but unsuccessful attempts by birds to break off the offending retrices. Only one painted bird, ♯157, an immature male, obviously conscious of the yellow on his tail, broke off all his retrices above the paint mark. On February 14, 1952 several of his retrices were removed in order to induce regeneration of the retrices important to the bird's welfare. Field identification was temporarily assured by a yellow wing mark. One other bird, a new female caught in mid-February, had lost all retrices thus necessitating painting the wing coverts. This bird was later observed among an aggregation .5 miles northeast of Station 2 on February 23, 1952. A possibility of individual interference of courting due to consciousness of the colored retrices is evident in only a low percentage of marked birds.

The necessity of painting only dry retrices required holding the birds overnight to dry on only a few instances.

The most serious handicaps in the method of final determination of distribution by use of the marking process were lack of time, and physical inability to be at the proper place at the proper time.

After October 24, when painting began in earnest, the daily routine of banding so filled the daylight hours that immediate determination of recently marked birds' travels was impossible. The month of November, during which 75 Cardinals were marked, allowed only four good days of observation. Twenty-nine of the 75 birds never repeated at the traps and it was this group of birds in which the greatest interest lay since they may have travelled great distances. The four days of observing could only indicate directions of possible dispersal and only males and females, as age is not discernible in the field. See Tables 14 and 16. Directions and minimum distances could be proven for observed Cardinals but no data were available to prove that all marked Cardinals reacted in the same manner.

The following data must be recognized as indicative and, however expressed, they must serve as the only means of study under existing circumstances.

On November 13, 1951 a silver female from Station 3A was observed at Station 4. She was one of 12 silver females that had been marked. She had travelled 1.2 miles southwest. It is thought that she was ♯139, a silver immature female, which had been captured on November 12, 1951 at Station 4. No other silver females were observed in any area at this time. On November 14, 1951 two silver females were observed over one mile northeast of Station 3A and these represented two of 12 silver females marked by that time. With ♯139 these two could represent three of 12 silver females accounted for since it is unlikely that ♯139 would have joined another female at a distant point in such a short time. These observations established that radii of 1.2 miles in opposite directions had been travelled by female Cardinals during a known period of time, and indicate an active travel condition among the sex.

On November 14, 1951, during the above observation, a blue male and a blue female were observed 1.8 miles northeast of their original marking point, Station 4. These birds indicated the general restlessness and a greater potential

TABLE 14

Painted Birds Observed in the Field At or Over Recovery Distances from Their Original Station

STA.	NO.	COLOR	SEX	DATE	DIST.	DIR.
3A	1	Silver	F	11-13-51	1.3 mi.	SW
3A	2	Silver	F	11-14-51	1.0 mi.	NE
3A	1	Silver	M	2-1-52	1.2 mi.	SW
3A	1	Silver	F	2-14-52	1.2 mi.	SW
3 or 3A	1	Silver	F	2-16-52	2.3 mi.	NE
Total	6				8.0 mi.	
2	1	Yellow	M	12-6-51	1.2 mi.	SW
2	1	Yellow	F	12-8-51	1.3 mi.	N
2	2	Yellow	M	12-27-51	1.2 mi.	SW
2	1	Yellow	F	12-31-51	1.75 mi.	SE
2	1	Yellow	M	1-11-52	1.3 mi.	N
2	1	Yellow	M	2-1-52	1.2 mi.	SW
Total	7				8.9 mi.	
4	1	Blue	F	11-14-51	1.8 mi.	NE
4	1	Blue	M	11-14-51	1.8 mi.	NE
4	1	Blue	F	12-7-51	1.2 mi.	NE
4	3	Blue	F	12-15-51	1.8 mi.	NE
4	2	Blue	M	12-15-51	1.8 mi.	NE
4	1	Blue	M	12-20-51	1.2 mi.	NE
4	1	Blue	F	12-20-51	1.2 mi.	NE
4	1	Blue	M	12-28-51	1.3 mi.	NE
4	1	Blue	F	1-14-52	2.3 mi.	E
4	1	Blue	F	1-20-52	1.2 mi.	NE
4	1	Blue	F	2-4-52	1.2 mi.	NE
4	1	Blue	F	2-19-52	1.2 mi.	NE
4	1	Blue	F	2-23-52	2.8 mi.	E
Total	16				26.2 mi.	
1	1	Red	F	9-25-51	1.0 mi.	N
1	1	Red	F	1-14-52	1.5 mi.	E
Total	2				2.5 mi.	

Station Averages

Station 3, 3A—Average distance 1.33 miles, (5 females, 1 male) 3 northeast, 3 southwest.
Station 2 —Average distance 1.27 miles, (2 females, 5 males) 2 north, 5 southwest.
Station 4 —Average distance 1.63 miles, (11 females, 5 males) 14 northeast, 2 east.
Station 1 —Average distance 1.2 miles, (2 females) 1 east, 1 north.

Total Males Painted 61
Total Females Painted 68
Individuals Observed 31
Average Distance ..... 1.47 miles

TABLE 15

13 Cardinal Banding Recoveries from Both Seasons

BIRD NO.	AGE	SEX	STATIONS	DIST.	DIR.	DATE MOVED	ORIG. DATE
23	A	F	3 to 4	1.3 mi.	SW	12-18-50	12-15-50
23	A	F	4 to 3	1.3 mi.	NE	12-31-50	12-15-50
32	A	M	4 to 2	1.2 mi.	NE	1-7-51	12-17-50
22	A	F	1 to 4	1.0 mi.	N	9-25-51	12-16-50
139	I	F	3A to 4	1.2 mi.	SW	11-12-51	11-8-51
23	A	F	3 to 4	1.3 mi.	SW	11-18-51	12-15-50
57	A	F	2 to 4	1.2 mi.	SW	11-19-51	1-8-51
152	I	F	4 to 2	1.2 mi.	NE	11-19-51	11-10-51
138	I	F	3A to 4	1.2 mi.	SW	12-12-51	11-8-51
134	A	M	4 to 2	1.2 mi.	NE	12-21-51	11-6-51
134	A	M	2 to 4	1.2 mi.	SW	1-2-52	11-6-51
165	A	M	2 to 4	1.2 mi.	SW	1-2-52	11-17-51
154	I	F	3A to 4	1.2 mi.	SW	2-14-52	11-10-51

radius of range for Station 4 Cardinals. At the same time, yellow marked Cardinals from Station 2 were present in the group. Since no competition was apparent and the yellow Cardinals were within .6 miles of their original station, it is possible that aggregation formation was in progress. There were 25 to 30 Cardinals in the group.

On November 30, 1951 the absence of the silver and blue marked birds among the group, which contained three yellow females and two yellow males, at the location just mentioned was conspicuous. Later observations disclosed an increasing number of yellow marked Cardinals within the same general feeding radius from Station 2. The number of yellow-tails observed in this aggregation of up to 75 Cardinals reached a total of 20 but averaged about 16 on different days. The same situation, but with fewer blue birds observed in aggregation, existed at Station 4, and indicated the use of Station 4 as an urban feeding stop, probably due to the absence of a large roost area nearby.

On December 6, 1951 a yellow male was observed at Station 4 and he was one of 13 Station 2 marked males at that time. He had travelled southwest a distance of 1.2 miles. There was no apparent factor such as severe weather or predator trouble which might have forced him into an urban habitat, however, it is

TABLE 16

Color Marking Totals by Stations and Sexes

1951-52

	MALES	FEMALES	COLOR	TOTAL
Station 2	26	30	Yellow	56
Stations 3 and 3A	10	15	Silver	25
Station 4	25	23	Blue	48
Totals	61	68		129

thought that fear of being trapped might have been the cause of his urge to move. It may be noted that only three of eight observed Cardinals that moved into the urban habitat were females.

On December 7, 1951 a blue female and one of 17 Station 4 females marked by that date, was observed at Station 2 to the northeast. This observation indicated the direction trend noted above.

On December 8, 1951 a yellow female, one of 33, was observed 1.3 miles north of Station 2. She indicated the possibility that a limit of continuous cover had been reached as there was an expanse of open meadow beyond to the north, northeast and west of the location. This Cardinal increased the potential range of Station 2 birds to a 1.3 mile radius and added a northern direction trend to the range.

On December 15, 1951, after a severe cold and snow spell, two blue males, of 15 marked, and three blue females, of 18 marked, were observed 1.8 miles northeast of Station 4. This observation indicated a probable return to a domestic habitat during severe weather since it is likely that these birds had been in the woods and tangles to the north of the location and had not been observed before. There were also two yellow females observed with the group. This group was not later observed as such.

On December 20, 1951 a blue male, one of 15, and a blue female, one of 18, were observed in the vicinity of Station 2 and they may have been two of the Cardinals from the above observation.

Two yellow males, of 16 marked, were observed feeding at Station 4, 1.2 miles southwest of Station 2, on December 27, 1951. One of these was probably *# 165*, captured at Station 4 on January 2, 1952. He was thereafter a regular repeat at Station 4 and lingered until April.

A blue male, one of 15, was observed at Station 3A on December 28, 1951, 1.2 miles northeast of Station 4.

On December 13, 1951, a yellow female, one of 36, was observed 1.75 miles southeast near abandoned Station 1. This record increased directional and distance data of Station 2 Cardinals.

On January 11, 1952 a yellow male, one of 16, was observed 1.3 miles north of Station 2. This record coincides with the reshuffle of males already noted in the banding data. He increased directional and distance data for male Cardinals.

On January 14, 1952 a blue female was observed at the junction of Aaron Run and Deckers Creek, 2.3 miles east of Station 4. This Cardinal was probably the same one observed one half mile east of the same location on February 23, 1952. These records increased range radius and direction for Station 4 Cardinals.

A red banded female Cardinal was observed during the above January 14 observation and was one mile east of her original Station 1. This record and a recapture record are the only Station 1 recoveries. See Tables 14 and 15.

On January 14, 1952 a blue male was observed .75 miles northwest of Station 4. The record increased the directional data of Station 4 Cardinals and encouraged observations in the vicinity of the West Virginia University Arboretum and the across-river area near Monongalia High School, but no further records were

obtained. This again indicated that most of the Station 4 Cardinals were of domestic or "back yard" inclination in choice of habitat.

On February 1, 1952 a silver male, one of 10, was observed 1.2 miles southwest of Station 3A at Station 4. This record further demonstrated the suspected active condition of male Cardinals during the period of pre-mating.

A blue female was observed at Station 2 on February 4, 1952 and was later believed to have become a predator mortality near Station 2 in late February.

A silver female was observed at Station 4 on February 14, 1952 and was subsequently caught as *#154*, an immature female banded at Station 3A on November 10, 1951. She had also made a significant repeat at Station 2 on November 30, 1951. See Table 13.

A green banded female, one of 31, was observed on February 16, 1952 at a point 2.3 miles from the nearest green band station, Station 3. The location was northeast of Station 3 at a point between Easton and Stewartstown Road along U. S. Route 119. This record extended the known radius of Station 3 Cardinals.

A blue female, one of 23, was observed in the Station 3A area on February 19, 1952 and the record increased directional data for Station 4 Cardinals.

A blue male was observed along Wilson Avenue in South Park on April 13, 1952 and, although the record was not included in tabular form, it indicated the general dispersal of Cardinals during the height of nesting territory competition.

XII. RESULTS

One hundred Cardinals were color banded during five months of the first season but field observation was hampered by the observer's inability to see enough banded birds.

A great increase in local Cardinal population during November, 1951 made possible the painting of 100 Cardinals by mid-December, 1951. The painting of designs on the Cardinals' retrices improved field observation. A total of 136 new Cardinals were banded during only four months of the 1951–52 winter season.

Painting was stopped in mid-December, 1951 in order to allow more field observations but the presence of new Cardinals of both sexes at banding stations required renewal of painting, and some repainting of worn marks, until mid-February.

Banding was sporadic after January 1, 1952 and, although feeding was continued in opened traps, only on selected check days were the traps set for birds. After February 14, 1952 feeding was continued daily except for very warm days and by March 27, 1952 few Cardinals were to be seen in immediate station areas.

Two hundred forty-one Cardinals were field marked during eight months of banding and marking during the two winter seasons of 1950–51, 1951–52. Five of these were juvenile nestlings and were not counted in any percentages.

The field banding and observation hours during the second winter were appreciably reduced from 576 to 476. Part of this was due to the use of a head lamp, coon hunter type, during night operation, and fewer necessities of night banding. The two seasons of actual problem work in the field totalled 1052 hours.

It is to be noted by a comparison of Tables 14 and 16 that seven of 56 marked birds were observed at recovery distances from Station 2, while 16 of 48 were observed at recovery distances from Station 4. Six of 25 marked Cardinals from Station 3A were observed at recovery distances and indicate a greater comparative number of travellers per number of birds marked. The probable explanation is that Stations 3A and 4 lacked the requirement of roost, food and protection that the vicinity of Station 2 provided and, therefore, the Cardinals were forced into greater dispersal patterns.

The ratio of Cardinals that travelled was 20 females to 11 males, or 2 to 1. Any duplication of records may well be counter-balanced by those birds that remained unobserved.

Of the painted birds observed over recovery distances from their point of painting, 64.5% travelled in a northerly direction. The lack of southerly located observation stations reduces the conclusive meaning of the data.

The greatest number of recovery observations took place during December, but although this coincides with banding data it is altered by the fact that observation days in November were few and undoubtedly many records went unobserved.

Station 4 produced the greatest number of travelling birds and the highest average per number of birds painted. Station 4 also produced the Cardinal making the longest move, or 2.8 miles.

There were some observations in October of immature Cardinals still in family groups and under parental care.

Molting shyness during September and October was obvious and decreased the banding success.

Immature Cardinals of late summer or early fall broods were put on their own resources by November in this area.

The great activity of all Cardinals in the month of November corroborates part of Trautman's observation of spring and fall increases in population, as does the obvious influx of transient Cardinals that were observed in late February, March and April. This also corroborates Baldwin's banding records.

Cardinal winter wandering is limited to a great extent by availability of natural food, good roosts, water, and climate, but not entirely. Fear of man and other predators and being handled as trapped birds certainly exert some influence. Coincidentally there were recovery records made by Cardinals which were unexplained by lack of requirements as above noted.

The assumption, concerning 48% of Cardinals never knowingly observed after their original trapping, is that they either moved beyond the observer's limit of observation or were too shy to allow close enough approach to be observed.

The continual appearance of new Cardinals as captures at all stations throughout the winter indicates a general restlessness among almost half of the study Cardinals, as almost half were never again observed or captured.

Cardinal color consciousness of painted retrices was observed among only a few individuals. The effect of ruptive pattern of the designs may have confused some predators.

The favored wild foods of local Cardinals were beechnuts, wild grapes, yellow poplar seeds, and weed seeds.

The favored winter roosts of local Cardinals were, in order of favor, evergreen plantings, wild grapevine tangles, greenbrier tangles, and heavy domestic shrub plantings.

One hundred twenty-nine Cardinals were painted during the second season between September 17, 1951 and February 14, 1952. The paint remained a good field identification for from three to four months.

In eight months of winter banding, 236 Cardinals were banded.

The present bands supplied for Cardinals do not insure against removal, crimping or obliteration of serial numbers.

Recommendations

A strong recommendation is tendered the United States Fish and Wildlife Service to incorporate the use of Cardinal bands that cannot be defaced, crimped or removed.

It is hoped that this research will be used as a basis for further study, in which several competent observers can cooperate to obtain more conclusive data over a greater area and a longer period of time. The unsolved problems are unlimited, and with a proper plan in operation the results would be invaluable to science.

An appeal is made to the University Horticultural Experiment Farm directors to provide roost and cover conditions by leaving living vine tangles uncut in the many portions unsuitable for experimental work.

XIII. CONCLUSIONS

The greatest observed radius a painted Cardinal, a female, travelled from her point of painting was 2.8 miles.

The possible range of Cardinals from Station 4 was 5.6 miles on the basis of the known radius of 2.8 miles. On the same basis the range of Station 3A was 2.4 miles; the range of Station 3 was 5.2 miles; the range of Station 2 was 3.5 miles; and the range of Station 1 was 3.0 miles. These ranges may be considered as minimums.

Of 129 painted Cardinals, 68 females and 61 females, 31 were observed at recovery distances. They averaged 1.47 miles of minimum travel per observed bird in a ratio of two females to one male.

Ten of 236 marked Cardinals produced banding recovery records of distances of one mile or more. However, many more Cardinals were recaptured and seen regularly in station areas.

The longest observed move made by a marked male was 1.8 miles northeast of Station 4, his original station.

The greatest number of recovery records occurred during December and January of both seasons, indicating restlessness even during the aggregation periods.

Cardinal molt begins in September and is not generally complete until after mid-October in this area.

Aggregation establishment in 1951 began in early November or at the time

of the fall of deciduous leaves. Roost requirements and cover seemed to be the limiting factors.

Of the total new Cardinals banded during January, 1952, 66% were males and this indicates a mid-aggregation influx of the sex.

A number of transient males appeared during the first half of February as indicated by trapping records. During the same period adult females were passive and immature females were highly dispersed. An oncoming restlessness was noted with the lengthening of day, and warmer weather.

The ages and sexes varied in travel reactions during different winter phases. Adult males were more active and independent all winter. Adult females were comparatively more sedentary until mid-January when activity increased. Immature males were generally stationary throughout the entire winter until March. Immature females were temporarily static in October and November but were very restless thereafter. The above statements are based on an average of 53% of all study birds.

A continuous change of local range is indicated in the recapture of only 16% of the first season's Cardinals during the second winter.

The Cardinals observed at recovery distances favored a northerly direction in their travels, since 64.5% travelled in that general direction. This was an out-of-urban trend.

The observed daily feeding range of aggregations in the Morgantown, West Virginia area was approximately .75 miles from a given banding station.

Two seasons of banding data reveal that 51% of banded and/or painted Cardinals were recaptured as repeats. Of these, 20% were stationary in travel reaction.

Several instances of permanent range and winter pairing fidelity occurred among older adult Cardinals.

Cardinals in spring had greater feeding competition from Song Sparrows and Slate-colored Juncos in the banding areas.

From October, 1951 through November 10, 1951 the consistent presence of migrating Song Sparrows and White-throated Sparrows at banding stations temporarily postponed capture of many Cardinals. This hindered the progress and complete knowledge of fall moves.

Only a fraction of the study Cardinals moved into the domestic habitat during winter. The large beechnut crop in the winter of 1950–51 undoubtedly was the salvation of the "country" Cardinals during the severe 41 inch snow of November–December, 1950.

XIV. LIST OF OTHER SPECIES OF BIRDS CAPTURED DURING THE WINTER SEASONS 1950–51 AND 1951–52

Northern Flicker—*Colaptes auratus luteus* Bangs
Northern Downy Woodpecker—*Dendrocopus pubescens medianus* (Swainson)
Black-capped Chickadee—*Parus atricapillus atricapillus* Linnaeus
Carolina Chickadee—*Parus carolinensis carolinensis* Audubon
Tufted Titmouse—*Parus bicolor* Linnaeus

White-breasted Nuthatch—*Sitta carolinensis cookei* Oberholser
Eastern House Wren—*Troglodytes aedon aedon* Vieillot
Eastern Winter Wren—*Troglodytes troglodytes hiemalis* Vieillot
Carolina Wren—*Thryothorus ludovicianus ludovicianus* (Latham)
Catbird—*Dumetella carolinensis* (Linnaeus)
Eastern Brown Thrasher—*Toxostoma rufum rufum* (Linnaeus)
Eastern Robin—*Turdus migratorius migratorius* Linnaeus
Wood Thrush—*Hylocichla mustelina* (Gmelin)
English Sparrow—*Passer domesticus domesticus* (Linnaeus)
Eastern Cowbird—*Molothrus ater ater* (Boddaert)
Indigo Bunting—*Passerina cyanea* (Linnaeus)
Eastern Evening Grosbeak—*Hesperiphona vespertina vespertina* (Cooper)
Red-eyed Towhee—*Pipilo erythrophthalmus erythrophthalmus* (Linnaeus)
Slate-colored Junco—*Junco hyemalis hyemalis* (Linnaeus)
Eastern Tree Sparrow—*Spizella arborea arborea* (Wilson)
Eastern Field Sparrow—*Spizella pusilla pusilla* (Wilson)
White-crowned Sparrow—*Zonotrichia leucophrys leucophrys* (Forster)
Gambel's Sparrow—*Zonotrichia leucophrys gamgelii* (Nuttall)
White-throated Sparrow—*Zonotrichia albicollis* (Gmelin)
Mississippi Song Sparrow—*Melospiza melodia euphonia* Wetmore

The authority for the above nomenclature was the latest edition of the American Ornithologist's Union Checklist.

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